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THE PREPARATION OF MOULDS FOR STEEL CASTINGS.*

BY ARTHUR SIMONSON.

IN attempting to bring forward a few points in connection with the preparation of moulds for steel castings I realise that almost the best one can hope to do is to generalise on the subject. Every man has to fight his own moulding sand battles, because the conditions are as varied as human faces. The shape and weight of the pieces, the casting temperature, and, to a great extent, the availability of material, play such important parts that it would be impossible to write a standard treatise that would be useful to every founder. If a man in one place who is making excellent castings should write down in as full detail as possible his method of procedure and the man in another should take that information and try to do likewise, there would be no guarantee of success, the personal equation entering so largely into the making of moulds; in other words, the "know how" is what counts, and it is just this "known how" which is difficult to put on paper and transmit from one to another.

Moulders must be good Moulders.

Given good sand and plenty of muscle, it does not follow that a moulder will make good moulds. It is necessary to study carefully the pattern he is working on at the time, to adjust the pressure of ramming and the disposition of vents, gates, and risers to that particular case. The successful moulder is not the one who has the most muscle, but the one having sufficient of that useful commodity and also enough brain to do the above. A man should be proud to be a moulder, for it is a trade that calls for the highest degree of skill and intelligence, and in my opinion the moulder, as a mechanic, ranks as high as any. That moulding calls for high

* Read before the Philadelphia Foundry Foremen's Association at its October meeting.

development of skill is evidenced by the regrettably small percentage of good moulders that one finds in a day's march.

It has to be admitted that the general average standard of workmanship is higher in Europe than in America, and this is attributable to the long apprenticeship they serve—generally seven years—before they earn journeymen's wages. Then, again, there is much less of the tramp element than in the States. The men stick to one locality, and, indeed, to one shop for a great length of time, whereas the American moulders are a roving class, and no sooner get accustomed to the work in one place than it becomes monotonous and they float away to another. It has been said, aptly enough in some connections, that a rolling stone, while it gathers no moss, yet acquires a very fine polish. I fear this does not apply to moulders. The conservative English journeyman, with his seven years' apprenticeship, and his tool box containing a wonderful assortment of tools for every conceivable purpose, who stays all his life in the place where he learned his trade, is a treasure to his employer and can scarcely lose a casting.

During the past summer I visited in England the foundry where I took my first steps in the steel business. I had been away six years, but on entering the place it seemed that I had been away no longer than from Saturday to Monday. True, the place was much larger, but out of some hundreds of men whom I knew six years ago there were few absentees. The same men were there on the same floors, and in most cases, astonishing as it may seem, assisted by the same helpers, and they were doing the same class of work. There were orders for locomotive wheels and other parts that have been repeated, so that the same patterns were still in the sand. These are the places where the finest castings are made, and it would be strange indeed if it were not so if the old adage about sticking everlastingly at it has any basis in truth.

In giving advice, then, for the making of moulds for steel castings I would give it along the lines of that given to the man who asked how to skin a lion—"first catch the lion." In other words, first procure a good moulder and the rest will be easy. But in order to get something more concrete let us assume that all our moulders are the very best and see what is our part in providing them with suitable material, and then watch them at work. Let us see what are the conditions to be met with in considering the material to be used and the method of procedure in the preparation of the moulds.

Very Refractory Moulding Materials Required.

In our mind's eye let us picture a typical steel casting, an ordinary machine or engine part. Notice, however, that the skin of the casting is quite smooth, free from pits or scabs, worm-like markings or humps. It is a healthy, attractive looking casting of a fine blue-gray colour. Its corners are sharp and true, and in shape it is like the pattern from which it was made. Strike it with a hammer it rings true as a bell, showing there are no hidden cracks or hollow places. The mould in which it was made must have been perfect; of what material and how was it made? It had to stand high temperature, great statical pressure, relentless contraction, and at the same time be smooth enough to give that beautiful skin to the casting. Let us study these points a little closer.

The casting temperature of steel is in the neighbourhood of 3,000 degrees F. A very few hundred degrees in that high range of temperature make all the difference between hot fluid steel that will run the most complicated castings and sluggish pasty steel that will scarrely run a hammer block. To stand such a temperature the material of the mould must be very refractory. Moulding materials are chosen from the acid refractories—that is, their basis is silica. Silica forms the greater part of the earth's crust, and, therefore, silica materials can be obtained in almost any locality. The difficulty when it arises is to get them sufficiently pure—that is, free from other substances which, while probably themselves quite refractory, yet in contact with silica form a more fusible mixture. These impurities are chiefly the bases lime and magnesia.

There is little difficulty in obtaining very pure silica sand. In America I have analysed a great many samples which run over 98 per cent. silica. France and Belgium produce also a very pure flint sand. Of course, this pure sand would be entirely useless for moulding purposes in its natural condition, and it has to be mixed with other things to make it useful, but it must be regarded as the basis of all steel moulding sands on account of its infusibility. Sometimes nature provides us with a sand which contains all the necessary ingredients in the

natural state, but this is comparatively seldom. In regard to the chemical analysis of steel moulding sand it is a fact that this is not much of a guide, for it is the proximate analysis that counts, not the ultimate. In other words, take two sands of exactly the same chemical analysis, and one may be an ideal moulding sand and the other useless. It depends on the condition of the elements in the sand.

It is necessary that moulding sand should be plastic in order that it may retain the shape imprinted on it by the pattern. This plastic property is given by a certain small percentage of clayey matter or alumina. In one sand the percentage of alumina may be high, but it may be combined with the silica and the sand will not be plastic. In another sand a less proportion of alumina in the free state will make the sand adhesive, and, consequently, fit for moulding. In my experience I have always found it better to start with a pure quartz sand and then give to it sufficient body for different purposes by adding varying proportions of a pure clay of known analysis. In this way one has complete control of the strength of the sand, and can change it for different purposes to meet the gradations of weight in the castings, and whether they are to be made in green sand, skin dried, or dry sand. Analyses of three samples of quartz sand obtained from different parts of the United States are as follows :—

	One per cent.	Two per cent.	Three per cent.
Silica	96.60	98.61	97.61
Alumina, iron ...	2.57	0.77	1.41
Lime	0.41	0.25	0.39
Magnesia	0.40	Trace	Trace

A suitable clay of very fine quality analyses as follows :—

	Per cent.
Silica	71.03
Alumina, iron	22.51
Lime	0.35
Magnesia	Trace
Water and organic matter	6 2

Mixing the Sand and Clay.

Mixing any of the sands and the clay mentioned above in proportions to give from 90 to 95 per cent. of silica and from 3 to 5 per cent. of alumina will give a composition suitable for almost any class of casting. This sand will be much stronger than natural sand as a general rule and decidedly more uniform.

The inking is generally done in a pan grinder with heavy chilled iron rollers. Centrifugal mixers are not so successful, for reasons that will be explained later. The sand and clay in requisite proportions being placed in the grinder, they are moistened with molasses water to such a state that when a quantity is taken in the hand and squeezed a few grains will stick to the hand. It must not cake on the palm or it is too wet. Molasses water is used to give greater body to the sand in the green state, and also because it does not evaporate like plain water. The sand is rolled in the grinder for ten to twenty minutes, and if its condition be felt with the hand from time to time, it will be noticed that it becomes stronger the longer it is left in. This means that every grain of sand is uniformly coated with clay, and explains why centrifugal mixers are not so successful. The heavy rollers thoroughly incorporate the clay with the sand, but they should not be so heavy as to crush the grains.

As to the size of the grains, it is wise to use two grades, one quite fine with rounded grains and the other much coarser and with more angular grains. The fine part of the sand insures a smooth face, and the coarse part serves to open up the pores and provide a ready means of exit for the gases formed during and after pouring. As regards the strength or toughness of the sand, it should be such that on squeezing some of it in the hand the lumps so formed will retain their shape and sustain a slight pressure between finger and thumb before collapsing. This is a more delicate way of testing the strength of moulding sand mixtures than appears at first sight. The fingers are very sensitive, and sand can be very accurately graded by this means.

The Mechanical Properties of the Mould.

Passing to the second point, which concerns the mechanical properties of the mould itself, we shall try to deal with the question of pressure, contraction, etc. A mould has to stand an enormous pressure, as all know who have seen clamps burst, and holding-down weights and copes lifted by the rising metal. Not only is there the fluid pressure caused by the weight of steel and the head due to the height of the ladle, but there is the pressure caused by the expansion of the air and the large amount of gases generated while the mould is being poured. Flasks for steel castings, therefore, need to be heavier and stronger than for iron castings, and all the accessories, such as clamps, plates, etc., also need to be correspondingly stronger. As for the mould—that is, the sand part of it—it must be constructed to stand

the strain that is put on it; all projections must be well rodded, the ramming firm and even, and the gates and risers cut in such a manner as to relieve the strain as much as possible. It is wise to run castings from the bottom when feasible.

What happens when the mould is poured full? The steel begins to shrink, and if it is a plain shape like a sphere or a cube it will shrink away freely from the mould on all sides. But few castings are so simple. They have projections, bosses, ribs, etc., and consequently when they begin to shrink they meet resistance from the mould. At the instant of setting or becoming solid, steel has practically no physical strength; so if the mould is too rigid the result will be that the casting will pull apart. We therefore need a mould to be very strong at the moment of pouring and quite collapsable a few minutes after. If the sand is mixed right this will be the case, as a few minutes at such a high temperature will serve to destroy the binder and the sand becomes "rotten" and powdery.

The fact that steel castings are frequently very much warped or twisted when taken out of the sand shows the resistance that was offered to the free shrinkage of the metal. It is almost impossible to avoid this in some cases, but steps can be taken to reduce it to a minimum. This can be done by ramming cinders, sawdust or shop sand in pockets at the places where the most shrinkage is going to occur. Cracking and warping may be avoided by shaking out the castings while very hot, before the shrinkage has all taken place. This must be done very judiciously, however, or it may result in worse trouble than it was intended to cure.

The smooth face of castings is obtained by coating the moulds with a liquid wash consisting of flour silica, a little clay and molasses water. This should produce on the mould when dry a very thin skin, very rigid, and with a feel like velvet. It should be possible to rub the powder off to some extent. On this surface the steel will lie quietly without burning in, on account of its specially refractory nature, and it at the same time permits gases to pass freely through it to the more open-grained sand behind.

Referring briefly to the technique of moulding, we can make the moulds in snap flasks or on the moulding machine and the moulds would be made in green sand and the procedure identically the same as for cast iron. The sand is used as dry as convenient, and only sufficient clay is used in its composition to make it just stick together when squeezed or rammed.

As regards the ramming, this is probably the most important part of the business. It has to be done more carefully than for iron, and this I say advisedly, for the steel is much hotter and more searching, and will detect variations in hardness, with the result of cutting or scabbing. When a mould is dressed it is generally finished with flat-headed wire nails, which hold the sand together and cool the face of the casting slightly. The mould must be thoroughly well ventilated, both cope and drag. This is very important.

Core Making.

This section of the steel foundry business is often relegated to a secondary position, though it is truly as important as the moulding. The fact that undoubtedly the greatest proportion of defective castings are caused through defects in the core shows that it is a department needing the closest attention. In a core we have generally worse conditions to meet than in the body of the mould, for, generally speaking, the steel shrinks away from the mould, but it shrinks on the core. On the other hand, a core does not, as a rule, have to stand the same amount of cutting action as the mould, as the gates should be cut to avoid impinging on a core whenever possible. Cores should, therefore, be specially refractory and "rotten," but they must be strong enough to handle and to bear the pressure of the rising metal.

In making a core the idea is to produce a strong exterior and a weak interior. This is done by ramming up the core of some collapsable gravel or burnt sand mixed with oil or rosin and then painted with a thick wash of Ceylon plumbago, silica flour and molasses water. Two or more coats may be advantageously given and dried in between. Cores should be almost but not quite burnt. These remarks, of course, refer to cores of some size. Small cores are not generally coated with wash.

Summing up, it may be said that there is very little difference between iron moulding and steel moulding except in details. The difference is chiefly in the different kinds of sand used, and the fact that almost all steel moulds are thoroughly baked or dried. But there is an increasing tendency to make steel castings in green sand moulds, and as

sand mixing and composition become better understood this will be still more so. Iron moulders make very good steel moulders with a little practice and instruction. The conditions are the same, only accentuated. The temperatures are higher, and, therefore, more gases are generated, and we need more open sand and more refractory moulds. The higher temperatures also cause higher pressures, calling for stronger moulds. There is also a greater cutting action due to the chemical composition of the metal. But there are being produced to-day in increasing quantities steel castings of magnificent appearance and satisfactory physical qualities.

A NEW MOULD DRYER.

PARTICULARS of the Mathewson patent mould dryer have been sent to us by Messrs. J. W. and C. J. Phillips, of 23, College Hill, E.C., who are interested in its sale. The dryer is illustrated herewith, and it is claimed does not require a crane like the usual type of dryers, and can be moved about easily by two men. Compressed air is supplied at 20 lbs. pressure, and the dryer requires approximately 10 cubic feet of free air per minute. The outer casing contains an inner cylindrical fireplace which is lined with gannister. A flat hearth is

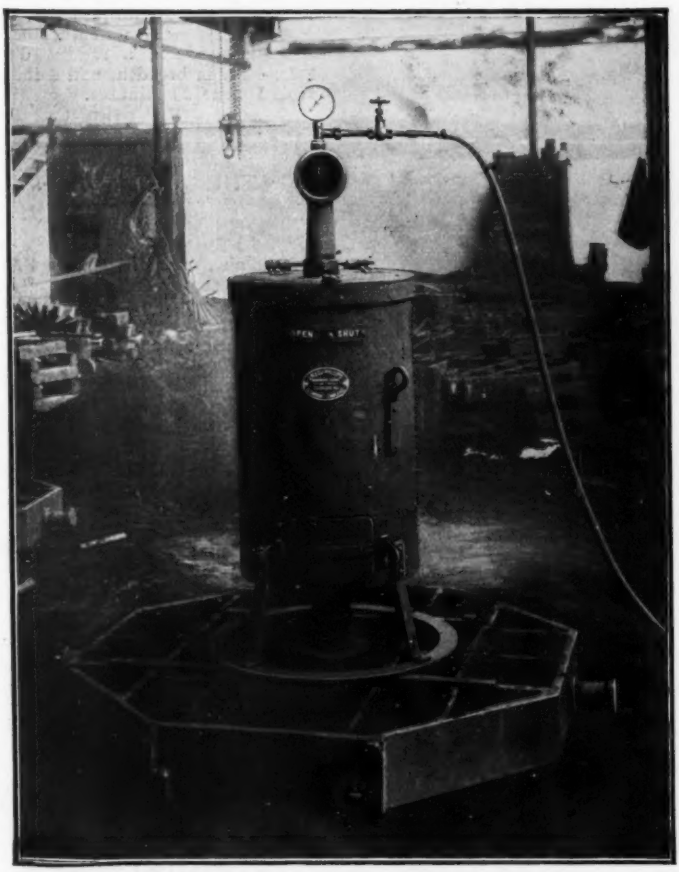

FIG. 1.—PHILLIPS' PORTABLE MOULD DRYER.

arranged a short distance from the bottom, to support the gas coke used. When the air is turned on it flows into the casing, part of it going through the top of the inner fireplace, and the other part passing through a perforated adjustable ring and down the annular space between the fireplace and the outer casing. The hot and cold gases are mixed in the chamber below, and by increasing

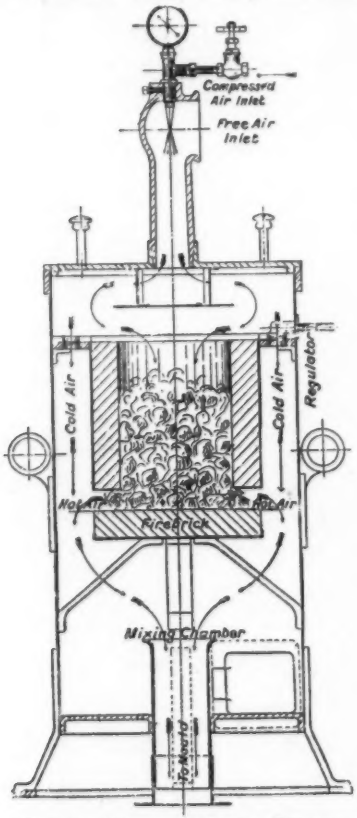

FIG. 2.—PHILLIPS' MOULD DRYER; SECTION.

the supply of cold air through the annular space after the dryer is well started, the correct supply of hot air to the mould is ensured without the risk of burning.

The dryer can be kept always ready for use, and a great improvement is effected by causing the air to pass downwards through the fire, the carbon and smoke being consumed—instead of being deposited in the mould, which, when the air is blown up through the fire, is more or less likely to happen. The height of the oven part is 3 ft. 8 in., and the total height to the pressure gauge is 5 ft. 4 in. The diameter of the casing is 21 in., and the weight is 3 cwt.

As an example of the times taken to dry some regular moulds, a cylinder, 12 in. diameter and 2 ft. long, took 45 minutes; a cutter-head, 36 in. diameter and 6 in. in depth, took 1 hour; a table, 72 in. diameter and 6 in. in depth, took 1 hour 30 minutes; and a saddle, 6 ft. long, 2 ft. 6 in. in breadth, and 4 in. in depth, took 1 hour 30 minutes.

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"THE WAY WE DO IT IN ENGLAND."

IT is always an instructive thing to see ourselves as others see us. The "Iron Trade Review" has recently published the following notes from Mr. P. W. Dillon, an American, who recently visited these shores:—

The Gobeille Pattern Company, of Cleveland, sent Mr. P. W. Dillon to England early in 1904. Mr. Dillon took with him a wooden pattern manufactured by the Gobeille Company, from which metal patterns were to be made in England, and used in the manufacture of radiators. Mr. Dillon took this pattern to the works of Lumby, Son, & Wood, Limited, near Halifax, Yorkshire, a concern which manufactures welded boilers and hot water boilers for house heating and radiators.

Mr. Dillon's work was principally in the introduction of American methods in the moulding of the radiator coils. The firm gave him *carte blanche*, and he was entirely free to order any supplies or introduce any methods that he saw fit. The wooden pattern that he brought over from America was copied in metal, and then carefully placed away, and the metal patterns used entirely in the foundry.

The Foundry.

The quality of sand used in the foundry did not begin to compare with that obtained in the United States. It was rather course and of a slightly reddish colour, and always before using it was necessary to break it up and sometimes to grind it, in order to bring it to the requisite fineness for making a good mould.

Moulding machines were almost unheard

of in the district into which Mr. Dillon went. In fact, there was great opposition on the part of the journeymen moulders to the introduction of any form of labour-saving machinery. In the United States Mr. Dillon found that the average moulder would turn out in one day about 35 moulds of the type he had taken to England. In the works in England he counted it a good day's work if he got 25 from a man. Shortly after starting work he decided that an ordinary labourer could be broken in and taught to do the work of moulding radiator coils as well as a journeyman moulder could. He tried the experiment, and made a success of it. A labourer who was getting 18s. per week for ordinary labour would be brought into the factory and instructed in the art of moulding a radiator coil. He would be under instruction for about one week, merely being expected to turn out a certain quantity of work each day. After spoiling a number of moulds and being shown his faults in each case by the foreman, he would, in about a week's time, become fairly proficient. He would then be put on piecework and managed to make about £2 per week.

The sand was of such a nature that the mould had to remain in the flask until poured. An attempt to use snap flasks was made, but the objections of the workmen and the quality of the sand made the attempt futile. The workmen were not used to snap flasks, and absolutely refused to use them. When compelled to use them they took care that the proportion of failures to perfect moulds was much greater with a snap flask than with the ordinary type. The flask used in the shop was made of cast-iron, and was about three times as heavy as would be thought necessary in the United States.

Mr. Dillon also tried the experiment of using labourers as moulders on the sections for the hot water boiler for house heating. This was not a success, however, as there was more or less patching to be done on moulds for these pieces, and it was soon found that only a skilled journeyman possessed sufficient skill to do the work successfully.

Core Making.

In making of cores some difficulty was experienced from the inability to obtain molasses for use in the mixture. In England the price of molasses is so high as to make its use in the foundry prohibitive. In place of molasses a preparation of linseed oil was used, which, however, did not give nearly as satisfactory results. The foundry flour was of a much better grade than that used in the United States. The cores were usually made by boys, who managed to turn out very good work. The core oven was of a brick structure, and heated by means of a coal fire. The flues were so arranged that the hot gases from the fire had to go around all sides of the oven before reaching the chimney. The cores baked thoroughly and very evenly. The doors of the core oven were made of asbestos about one half inch thick, mounted in an iron frame. They were well balanced, and were raised and lowered with but very little exertion.

The Cupola.

The iron used in the foundry was melted in a cupola of about 25 tons capacity. The air used to blow the cupola was furnished by means of a pressure blower, which was driven from a line shaft. The air before being blown into the cupola was heated in a box situated just below the charging door. The cupola lining was stopped some 6 ft. below the charging door, and on the inner edge of the lining were placed sheets, on edge, and joined to the cupola at the top, thus making a box, which was directly exposed to the hot gases from the fire. The air from the blower was passed through this box, and thence into the tuyeres. Compressed air, into which oil had been injected, was also blown in at the tuyeres. It was estimated that a saving of about 15 per cent. in the coke used was obtained by pre-heating the air and injecting oil into the fire. The ratio of iron to coke in the cupola was about ten to one. Both pig and scrap iron was used in the charges. The scrap contained a rather high percentage of silicon, in order to obtain sharp castings. The cupola was situated at one end of the room, and the men carried the molten iron in long-handled ladles which contained enough iron to pour about two moulds. The foundry contained no trolleys for carrying the metal to the various moulds, nor were there any overhead cranes installed. This necessarily made the work of pouring slow, but the carrying of metal in ladles was a method that the men had always been used to, and which they preferred.

The Workmen.

The personality of the workmen was a matter which occasioned considerable trouble. They were very set in their ideas as to the amount of work that should be done and the privileges which they should be accorded. They had a fixed objection to piecework, though the

labourers who were broken in as moulders were able to make higher wages by this system than they would under a day rate. The premium plan was tried with the journeymen moulders, who were engaged in moulding sections for the hot water boiler. They were to receive 8s. per day, irrespective of the quantity of work they turned out. For every mould over 20 that they made they were to receive twopence, but they never earned over 8s. On trying the premium plan with the labourers, who were making radiator coils, it was found that in their anxiety to obtain a large amount of premium money a great many moulds were spoiled, thereby greatly decreasing the efficiency of the shop. The plan was abandoned, therefore, and the labourers kept on straight piecework and the journeymen moulders on day work.

The tin dinner pail is unknown in England, the workmen bringing their lunch in a large red handkerchief. They do not carry coffee, as do the great majority of workmen in the United States. Aside from beer and ale, the chief beverage of the English workman is tea. All factories and shops in England are required by law to provide a dining room for their employés. In this dining room the workmen obtain their tea, or procure it at the public-house.

The men are also much addicted to smoking. They smoke at all hours both in the shop and out. In fact, they consider it an infraction of their privileges if they are required to abstain from smoking during working hours. It would be thought that there would be great danger of fire in the shops from this cause, but the buildings are usually so well constructed that fires are of rare occurrence. The fire protection system installed in the works is usually so complete that when a fire does occur it is extinguished with but small loss.

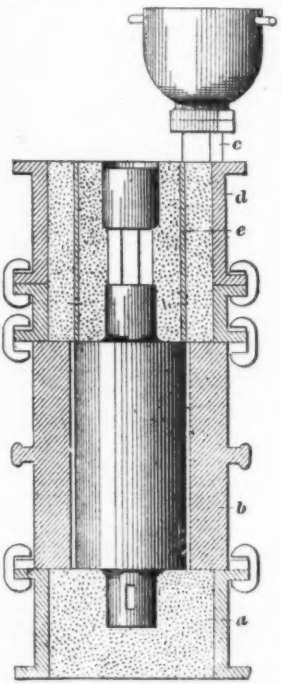
The Wages.

The wages of all workmen are low compared with those received by men doing corresponding work in America. The labourers receive about 18s. per week. The moulders and other journeymen receive about 48s. per week.

The foremen, as a rule, are well paid, receiving usually £5 per week. Their duties consist merely of instructing the men and seeing that they are provided with plenty of work. They are not required to do any clerical work whatever. A large office force is provided in all the better classes of shops, including timekeepers, cost keepers, and sundry others.

MANUFACTURE OF CHILLED ROLLS.

It is well known that not only the depth, but also the hardness of the chill on a roll or other article depends upon the rapidity with which the heat is carried away from the molten metal and the efficient persistence of the cooling action. The contraction of the molten metal during cooling and solidification and the expansion of the chill ring when heated,



Seaman's Method of Chilling Rolls.

produce such a separation of the chill ring and of the cast metal that the former will not act by conduction to cool the cast metal, and the heat retained in the casting by reason of the heating of the chill ring and its failure to carry away the heat will produce an annealing or softening effect on the chill produced by the first contact of the metal with the chill ring.

An invention which has for its object the employment of a chill ring which will act effectively during the internal cooling of the metal and the substitution of a second and preferably slightly smaller

chill ring for the first, whereby the article will be subjected to a secondary chilling action, is the subject of a patent granted to Mr. Joseph S. Seaman, of Pittsburg. The invention is shown in principle in the accompanying illustration.

The mould, as regards the drag A, the chill ring B, and the runner C, is constructed in the usual or any suitable manner. The cope may be constructed, as is common, to permit the chill ring to be drawn up outside of it, or, as is preferable, the cope is made in two vertical sections, separated from each other by a thin metal ring E. The matrices for the roll-neck wabbler and sinker head are formed of clay within the ring E, which has an external diameter less than the internal diameter of the chill ring B. The space between the ring E and the cope frame E is filled with material such as sand, which will not cake or harden when heated. After the mould has been formed in this manner the metal is teemed in through the sprue, as is customary. The molten metal, in coming in contact with the chill ring, is cooled and hardened, and as the heat is conducted away from the metal by the chill ring the latter will expand and the casting will contract. These opposite movements will so separate the casting and the chill ring that the latter will no longer act with the desired efficiency. This loss of efficiency is due not only to the separation of the casting and chill ring, but also to the heating of the chill ring by the molten metal. As soon as this separation of the casting and the chill ring has taken place, and the shell of solidified metal forming the chill of the casting has become sufficiently rigid to prevent deformation of the casting on removal of the casting, the cope frame and the material between it and the ring E are removed and the chill ring B stripped from the casting. The second chill ring, of slightly smaller diameter than the original, is slipped down on to the casting. As this ring is cold, and will come in direct contact with the surface of the casting, a second chilling action will occur and will continue for a longer time, as the contraction of the casting at this stage is not so rapid as at first, nor will the second chill ring be heated and expanded as rapidly as was the original one.

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THE average net selling price of manufactured iron at works in the North of England for the two months ending August 31 was £5 18s. 11.56d., against £5 17s. 6.92d. in the previous two months.

A NEW CUPOLA.

THE difficulty in cleaning and repairing the lining of small cupolas has prevented their general use. In emergencies, such a cupola would be a very great convenience if it could be easily managed.

Mr. W. J. Keep, of Detroit, Michigan, U.S.A., has designed a cupola, made in sections, to meet this want. The sections are 18 in. long and 28 in. outside diameter. These are lined with ordinary brick laid flatwise, the edges being

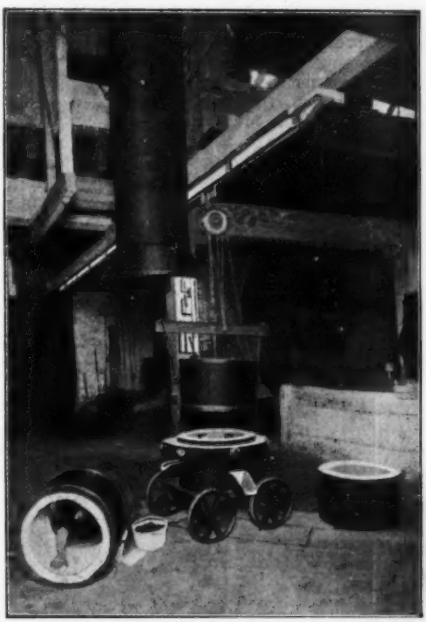

FIG. 1.—VIEW SHOWING THE KEEP SECTIONAL CUPOLA; TAKEN APART.

bevelled to keep the bricks in. The complete lining is 3 in. thick, making the inside diameter 22 in. A ring of 1½ in. angle iron is riveted to both ends of each section for stiffness, to hold the brick in place, and to make a joint between sections. The lower section contains a wind box and six tuyeres, 4½ in. square on the inside. This section is set on a solid bedplate on wheels, so that the cupola can be rolled to any point required. The sections can be handled by a light jib crane or by a trolley, placed a little to one side of the stack and with an ordinary chain hoist.

The stack is suspended by rods from the foundry roof. It is 24 in. in diameter, and flares at the lower end to 36 in. The lower end is 7 ft. 6 in. from the floor, and is just high enough for the cupola to roll under it. One side of the flaring portion is cut away for a charging door. The 3 in. opening between the top of the cupola and the edge of the stack creates a strong draught and keeps the air fresh around the cupola.

To take off a heat the bedplate is rolled under the trolley track, and the lower section put in place. The sand bottom is put in, 2½ in. thick at the front and 3½ in. at the back. The spout is lined, the breast put in, and a slag hole made at the rear. Shavings and kindling are laid in this section, and the other three sections put in place, daubing the joints on the inside.

The cupola is then rolled under the stack, and the pipe between the blower and the wind box connected. A charging platform should be made of boxes or flasks and 100 lbs. of coke charged. The

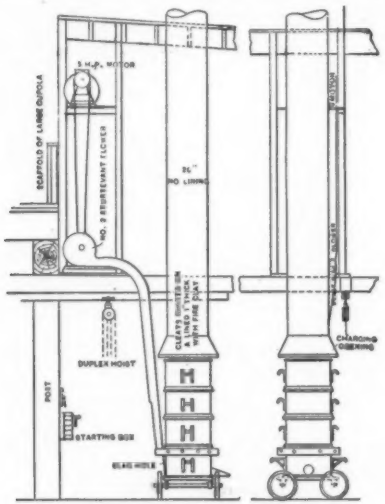

FIG. 2.—ELEVATION OF KEEP CUPOLA WITH ITS AUXILIARY EQUIPMENT.

fire should be lighted two hours before iron is needed. When the coke is well lighted 60 lbs. of coke and 200 lbs. of iron should be charged; then 30 lbs. of coke and 200 lbs. of iron, and so on. The cupola holds four charges, which can be put in in fifteen minutes. Details of the cupola are shown in Figs. 1, 2, and 3. The pig-iron must be broken into small pieces and evenly charged with the scrap.

The cupola will melt 2,000 lbs. an hour, and 18 charges, or 3,600 lbs., can be melted at one heat. The fan blast takes a 5 h.p. motor. The advantages of this

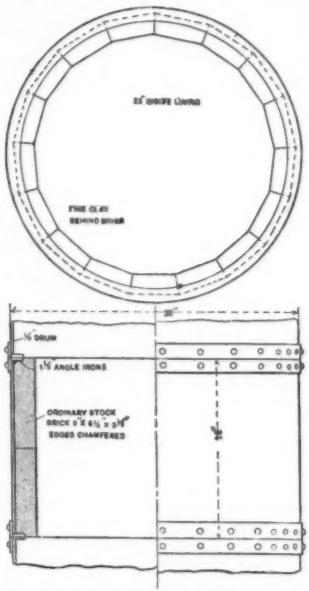

FIG. 3.—DETAILS OF A SECTION OF THE KEEP CUPOLA.

cupola are that if from any cause the large cupolas are not run, the foreman and his assistants mould and take off two or three heats and earn part, if not the whole, of their wages, and at the same time make work that is needed. During a shut down repair castings can be made quickly, or if an important piece is lost at the regular heat it can be made the same night or early next morning.

For special mixtures, such as white iron, chilling iron, semi-steel or soft iron for patterns, the results, it is claimed, will always be as calculated.

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ALFRED STEEL & SONS, LIMITED, has been registered to acquire the business of manufacturers of rollers, pulleys, malleable and common castings, etc., formerly carried on by the late A. Steel, at Brightside, Sheffield. The registered office is at the works, Meadow Hall Road, Brightside, Sheffield.

STEELE-HARVEY BRASS FURNACE TESTS.*

In October, 1904, we described the Steele-Harvey brass furnaces, placed on the market by J. W. Jackman & Company, of 39, Victoria Street, S.W. In a paper, read before the Pittsburg Foundrymen's Association, Mr. W. T. Krause gives the following account of tests made on this furnace :—

At the brass foundry of the Maryland Steel Company, Sparrow's Point, Md., over which I have supervision in connection with the general foremanship of the iron foundry, when I first took charge some nine years since we had six coke furnaces in use. Our business increased, and we were compelled to place six more in use, one of these for 300 crucibles. The others generally were for 100. We operated at a loss averaging 2.8 per cent. Several propositions were made in reference to oil furnaces, but being somewhat high in price the matter was dropped.

On one occasion our superintendent brought me an illustration of the Steele-Harvey melting furnace. I was very much impressed with it and requested him to get one on trial. The furnace arrived at our plant, and we had it installed ready for operation 24 hours afterward. Having an air compressor, it did not take a great deal of time to get matters in proper shape. We started the furnace green with 775 lbs. of metal and ran out our first heat in three hours. In the afternoon we ran out two more heats, making a total of 2,275 lbs. for the day. After the builder's furnace tender operated the furnace for two days he was sent home. Our own man, who never saw an oil furnace in all his life, was then put in charge, and he learned to handle it very readily, taking the first heat of 765 lbs. in 2 hours and 50 minutes. When he drew his third heat, which was ready for pouring at 5.10 p.m., he had melted for the day 2,225 lbs. The amount of fuel consumed was 48 gallons, at a cost of $1.20. A series of tests was made under my own supervision as follows :—

First Day's Run.

1,488 lbs. metal. Time consumed for melting, 5 hours and 50 minutes. First heat, 750 lbs., placed in crucible at 7.30 a.m. Metal drawn from furnace, 10 a.m.

Second heat, 738 lbs. Drawn from furnace, 12.50 a.m.

Loss in melting, 1.06 per cent. Amount of fuel consumed, 32 gallons, at a cost of 80 cents.

Second Day's Run.

Metal charged in four heats, 2,252 lbs. Furnace charged, 6 a.m. First heat drawn from furnace, 8.55 a.m.

Second heat charged, 9.10 a.m. Drawn from furnace, 11.55 a.m.

Third heat : Furnace charged, 12.20 p.m. Drawn from furnace, 2.50 p.m.

Fourth heat : Furnace charged, 3.25 p.m. Metal drawn from furnace, 5.45 p.m.

Loss in melting, 1.19 per cent. Consumption of fuel, 56 gallons, at a cost of $1.40.

Third Day's Run.

2,579½ lbs. of metal charged; four heats; time consumed in melting, 11 hours and 55 minutes; loss in melting, 0.96 per cent. Consumption of fuel, 65 gallons, at a cost of $1.62.

Fourth Day's Run.

2,534 lbs. of metal melted; four heats; time consumed in melting, 11 hours and 10 minutes; loss in melting, 1.03 per cent. Consumption of fuel, 62 gallons, at a cost of $1.55.

Oil in tank was measured before and after each heat.

On comparison with the above I will give data of four heats melted in a coke furnace a month previous to the installation of the oil furnace, as follows :—

1,465½ lbs of metal melted; loss in melting, 2.7 per cent.; cost of fuel, $1.98.

975 lbs of metal melted; loss in melting, 2.8 per cent.; cost of fuel, $1.24.

1,547 lbs. of metal melted; loss in melting, 2.8 per cent.; cost of fuel, $1.89.

534 lbs. of metal melted; loss in melting, 2.9 per cent.; cost of fuel, $1.29.

The average loss in melting in the oil furnace for four days' run shows 1.06 per cent. against 2.8 per cent. for the coke furnace.

Synopsis of Test in Oil Furnace.

Pounds.			Dollars.		Loss.
1,488	...	32 gallons oil, cost	0.80	...	1.06
2,252	...	56 gallons oil, cost	1.40	...	1.19
2,579½	...	65 gallons oil, dost	1.62	...	0.96
2,534	...	52 gallons oil, cost	1.55	...	1.03
8,853½	...	215 gallons oil, cost	5.37		Av. 1.06
Crucible in 14 heats, pro rata cost	... ...	...	6.50		
			11.87		

Average cost of 100 pounds, including oil and crucible, 0.134 dollars.

Synopsis of Coke Furnaces.

Pounds.			Dollars.		Loss.
1,465½	...	Cost of coke,	1.98	...	2.7
975	...	Cost of coke,	1.24	...	2.8
1,547	...	Cost of coke,	1.89	...	2.8
534	...	Cost of coke,	1.29	...	2.9
4,521½	...	Cost of coke,	6.40	Aver.	2.8
Cost of crucible No. 275, average life, nine heats	... ...	...	8.67		

100 pounds metal, average cost, including coke and crucible, 0.33 1-3 dollars.

* Paper read before the Pittsburg Foundrymen's Association, September 11th.

At the request of one of our superintendents I made the following tests to ascertain the percentage of oxidation :—

Test No. 1.

	Pounds.
Copper	350
Tin	30
Zinc	10
Scrap brass	150
Gates	185
Total	725
Metal taken from pot	722

Test No. 2.

	Pounds.
Copper	400
Tin	40
Zinc	10
Scrap brass	150
Gates	150
Total	750
Metal taken from pot	748

The metal taken from the pots, representing the actual quantity received, showed a loss in each test of 0.41 of 1 per cent. Both tests were made in new crucibles.

The life of crucibles has been while in use since December, 1904, an average of 24 heats. On one occasion we ran short of crucibles, and I placed one in a furnace that had run seven heats in a coke furnace. This was set aside as being too risky to run more heats from; it stood 22 heats, making a total of 29 heats.

Our furnace ran six months before we were compelled to reline it, and then we only put in the inner course, leaving the outer course of bricks in, which are still in use; this work did not require the aid of a mason, but was done by the man who ran the furnace.

The life of the carborundum brick in the bottom of the furnace that acts as the seat for the crucible will last, with care and proper attention to slagging of the furnace, about two months. Stress should be laid on the furnace tender to keep the furnace free of slag by removing it when in a liquid state and to always have the crucible set in the centre of the furnace firmly upon the carborundum base block, so as to secure a uniform flame and perfect combustion.

One thing must be understood, and that is, it is not an automatic arrangement. You do your part of the work and the furnace will do the balance.

The air pressure for working our furnace averages 80 lbs. Our air line to oil tank has a reducing valve connected to the air pipe, cutting down the pressure to 20 lbs. We were compelled to do this, as our oil tank was placed outside of the building and about 2 ft. below the level of the furnace. Where the oil tank can be placed above the furnace pressure in the tank is not required. Care must be taken when operating the furnace to get thorough combustion. This can be accomplished in operating the air and oil valves.

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COURSES FOR FOUNDRY SCHOOLS.—Mr. Pfahler, an expert, has recently outlined the following course as being suitable for a foundry school :—

1. Preparing and mixing sand.
2. Making and baking cores.
3. Facings, their use and preparation.
4. Bench moulding of ordinary patterns.
5. Match plate work.
6. Making sand and plaster follow boards.
7. Floor moulding. (*a*) Casting of patterns of complicated form which require the use of drawbacks, anchor plates, checks, etc. (*b*) Dry sand, loam and pit moulding. (*c*) Sweep work and green sand core making.
8. Cupola management. (*a*) Cleaning, lining, preparing charges of iron. (*b*) Charging, melting and management of cupola.
9. Cleaning and tumbling castings.

Supplementary Instruction.

1. An elementary study of the laws of heat, combustion and gases.
2. Mechanical properties of the different grades of pig-iron and their mixtures.
3. The methods of storing and checking patterns.
4. Estimates and prices and source of materials.
5. Excursions to commercial establishments and a study of their methods.

In concluding, Mr. Pfahler says : "The education which a boy gets in that foundry not only equips him for a good mechanic, but it gives him the ability of management, and he will come from that school equipped to supply the greatest want in the foundry trade to-day, which is the foundry foreman.

——o——

THE DALZIEL BRIDGE AND ROOF BUILDING COMPANY, LIMITED, of Motherwell, lately obtained an order from the Coltness Iron Company, Limited, of Newmains, for the erection of a new steel foundry. The buildings will cover an area of 2,670 square yards, and will be entirely constructed of steel, covered with corrugated sheeting.

THE STEEL CASTING INDUSTRY OF SHEFFIELD.—II.

At their extensive Norfolk Works, Messrs. Thos. Firth & Sons, Limited, make not only steel for all classes of tools, for swords, bayonets, and scabbards, but also armour-piercing and other projectiles, cranks and wheels, and other heavy work. It is a long stretch from a clock spring to an armour-piercing projectile, but the Company make the steel for both, and

FIG. 1.—INTERIOR OF CRUCIBLE FURNACE HOUSE; THOS. FIRTH & SONS, LTD.

complete the projectiles themselves. The business, which was destined to become so pre-eminent, was started by Mr. Mark Firth and his father, Mr. Thomas Firth, in the year 1840, when the valley of the Don presented a rural aspect, with fresh pasture land and a pleasant winding stream; 65 years have made a vast difference to the scene, and also in the importance of Messrs. Thos. Firth & Sons, whose name and fame are now known in many lands. Given a good foundation by Mr. Mark Firth and his father, later generations of descendants succeeded in developing the business in a remarkable way, and to-day the works cover acres of ground. From the commencement of the Norfolk Works, the management have had as their aim the production of a high and uniform quality of steel, and the success which they have attained has enabled the Company to establish agencies in Paris, Berlin, Frankfort, Hamburg, Brussels, Copenhagen, Barcelona, Turin, Moscow, St. Petersburg, Odessa, Montreal, New York, Boston, San Francisco, Mexico City, Johannesburg, Fremantle, and other places.

The extensive works at Sheffield, which stretch alongside the Midland Railway, have numerous well-arranged and equipped workshops, where some 2,000 men are engaged. To provide the motive power some 3,000 horse-power is used. An idea of the extent of the premises will be obtained when it is mentioned that in one of the melting furnaces there are holes for 100 crucibles. At the crucible furnaces alone 200 men are engaged in the manu-

facture of steel, mainly for fine tools. The annual capacity of output is about 5,000 tons of crucible and 30,000 tons of open-hearth steel. In the Siemens furnaces the steel for ordnance, shafting, cranks, tyres, etc., is manufactured, and unless specified otherwise, all forgings of large size are made by this process. In this building there are four furnaces ranging from 10 to 45 tons, and ingots up to as large a weight as 100 tons can be produced. Smaller work is turned out in a forge where a large number of men are

Particular attention has been given by the Company to the production of armour-piercing capped shells, and they have produced a new type of projectile which is designated "Firth-Rendable." The projectiles have successfully perforated Krupp cemented armour plate one calibre in thickness. As the projectiles are intended to burst after perforating the armour plates attacked, they have a chamber capacity to carry a bursting charge equivalent to 2½ per cent. of the total weight of the shell. The Company

FIG. 2.—MAKING CRUCIBLES; THOS. FIRTH & SONS, LTD.

engaged in hammering out steel to the dimensions suitable for piston rods, crank pins, cranks, crank arms, etc. Some mighty castings can be seen at times. A few months ago the Company completed a 20 ft. diameter mill wheel, which had a depth of 17 in. This gigantic wheel was to be cast in one piece, to be cut into segments, and its teeth to be milled to prevent vibration. Another casting 11 ft. 7 in. in diameter weighed about 15 tons. A cast steel spur wheel was 18 ft. 10 in. in diameter and weighed 7¾ tons.

also manufacture high explosive shrapnel and cast steel shell of all calibres. The firm is one of the largest suppliers of projectiles to the British Government, and has supplied Japan and Spain with large numbers.

Messrs. Firth & Sons are also large manufacturers of steel work for railway crank axles, and tyres in the rough and finished state for locomotives are supplied by them to the principal British, Foreign, and Colonial Railways. In the west gun shop where these axles and tyres are made, there are also manufactured mounted

wheels and axles for carriages and wagons, and locomotive tyres up to 7 ft. 6 in. in diameter. The work has to undergo some severe tests, and tyres for abroad have to pass through an even higher test than those for home railways. At the east gun works are made the cast steel wheel centres for locomotives and tenders. These are a speciality of this department, and the products have earned a wide reputation. Other locomotive castings include motion plates, axle bars, frame stays, etc. The output of steel castings is principally for locomotive, hydraulic, marine, and general engineering purposes. After such an extended experience, Messrs. Firth & Sons are fully aware of all the requirements that they may be called upon to meet by the railways of the country. In conclusion, reference may be made to some of the immense machinery necessary for turning out the exceedingly heavy work which the Company are able to undertake. There are hydraulic forging presses of 2,000 and 3,000 tons, which are capable of dealing with the largest forgings likely to be required, and the huge hardening tank has a depth of 75 ft., and holds 15,000 gallons of oil.

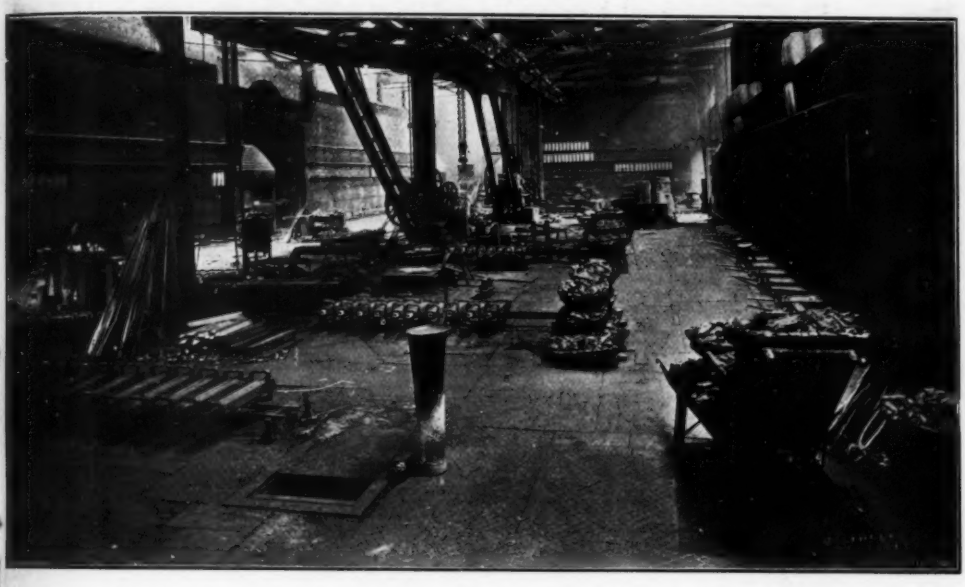

FIG. 3.—INTERIOR VIEW OF LARGE CRUCIBLE STEEL 100-HOLE MELTING HOUSE; THOS. FIRTH & SONS, LTD.

JOHN BROWN & COMPANY, LIMITED.—Like many other of the great firms of Sheffield, that of the Atlas Works has an interesting history, and a record of continual growth. Some fifty years ago the works were organised by Messrs. John Brown & Company. Mr. Brown had carried on business in a small way at Orchard Street and Furnival Street, Sheffield, and it was in 1854 that he made the plunge which led to success. In this year he acquired the Queen's Steel Works, previously carried on by Messrs. Armitage, Frankish & Barker. He re-organised the establishment, re-named it the Atlas Works, and secured as partners, Mr. John D. Ellis and Mr. William Bragge. Sir John Brown retired in 1870, the services of Mr. Bragge were unfortunately lost by death in 1884, but Mr. Ellis remains with the Company as Chairman of the Board. The Atlas Works, when they became the property of the three partners, covered only three acres. Now the area is 36 acres in Sheffield; and the area of the shipyard and engineering works at Clydebank is 78 acres. In addition to these, the Company are owners, or part owners,

of other industrial properties of considerable magnitude. In the year 1854 the works of the Company were valued at £14,050; at present they are worth two and a half millions. The greater part of the 36 acres of the Atlas Works is covered with buildings. The various processes of manufacture necessitate the use of 400 tons of coal and 100 tons of coke daily. There are 10 hydraulic presses, including one of 10,000 tons

FIG. 4.—INTERIOR OF STEEL FOUNDRY; THOS. FIRTH & SONS, LTD.

power; and 33 steam hammers. For manipulating heavy weights there are 94 travelling cranes. Two of them have a capacity of 150 tons, one of 100 tons, and the majority of the others 50 to 60 tons. There are 14 locomotives in the works for conveying the products from one shop to another on the many miles of railway running through the establishment. There are over 300 machine tools, many of them of great power, for planing, turning, boring, and otherwise shaping the forgings and castings. They are driven by prime movers developing an aggregate of 12,000 h.p., which is transmitted to the tools mainly through the medium of electricity. While the area occupied by the Atlas Works at Sheffield has increased twelve-fold since the works were commenced, the actual turnover of the Company has multiplied one hundredfold—from £30,000 to £3,000,000 per annum. The output fifty years ago was about 5,000 tons per annum; to-day it is close upon 100,000 tons. In all the works of the Company there are employed 20,000 workers, and the wages amount to about £1,250,000 per annum. These facts show the magnitude and the great importance of the firm bearing the name of John Brown & Company.

The steel industry of England owes a good deal to this Company. When the Atlas Works were commenced, spring steel was made almost entirely from im-

ported iron, mostly of Swedish and Russian manufacture, but the founders recognised that a good English iron could be produced to take the place of the Swedish, and the first important step was the erection of 12 furnaces for making the material. The furnaces had a capacity of 120 tons per week, and there was introduced in connection with them a steam hammer by Nasmyth, which, it is interesting to note, was the first steam hammer in use in Sheffield. In 1858 Sir Henry (then Mr.) Bessemer, found from the partners of the Atlas Works much encouragement, and although Sir John Brown did not at first look very kindly upon the system, the success of Bessemer's establishment, which adjoined the Atlas Works, was convincing, and an arrangement was entered into under which the partners of the Atlas Works became important factors in the ultimate commercial success of the new process. The first order which the firm secured for Bessemer steel rails came from abroad.

The firm were among the first to manufacture steel plates for shipbuilding, Bessemer steel being first used for the purpose about 1856. The open-hearth furnace, 10 years later, brought about a change, and Siemens furnaces were laid down to meet the growing demand. A step of national importance was the commencement by the firm of the manufacture of armour plates, and that by an entirely new process. The first experiments were made in 1859, and instead of adopting the customary hammering of the metal in the plate form, a mill was put down for rolling broad bars to the required width. These were piled upon each other, re-rolled, and welded together in sufficient numbers to make the desired thickness. Time works wonders, however, methods change, and Messrs. John Brown & Company's works are equipped with the necessary ponderous and modern machinery of to-day for the manufacture of armour plate very different from that with which they started.

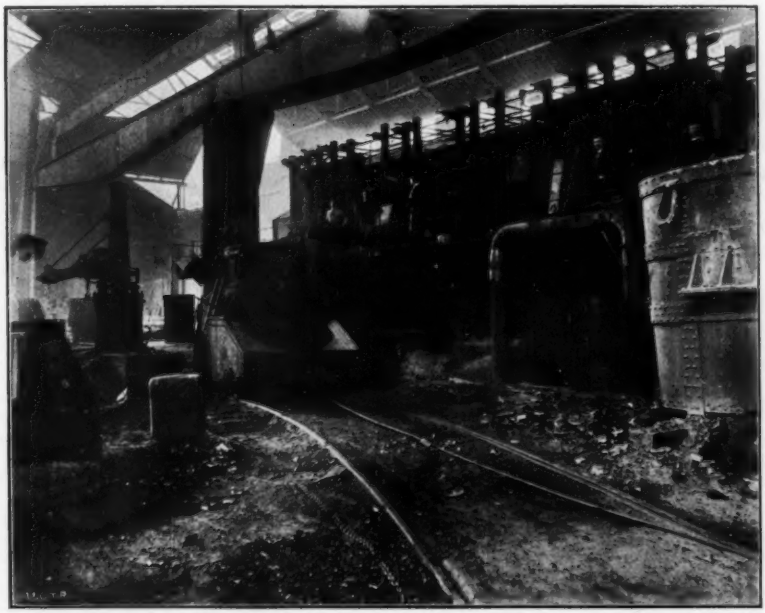

FIG. 5.—OPEN-HEARTH STEEL PLANT; JOHN BROWN & CO., LTD.

The changes necessitated by the introduction of the Bessemer system in 1858, with its converters and rolling mills, the laying down of immense armour plate rolling mills and machinery, and other improvements, caused the management to consider, in 1864, the expediency of con-

verting the co-partnership into a limited liability company, with a capital of one million sterling. Sir John Brown was the first Chairman, but six years later he retired, and was succeeded by Mr. John D. Ellis, who is still the Chairman, with Mr. Charles E. Ellis now as Managing Director.

In 1870-1872 the Company purchased iron ore mines in Spain, Lincolnshire, and Northamptonshire, and coal mines at Rotherham, a policy which has proved eminently successful. At the same time blast furnaces were built, and further developments made in production of rolling of plates, the casting of propellers, propeller bosses, etc., was undertaken. Many valuable improvements were made at the works from time to time, and in 1889 the "Robert" process of steel casting was introduced. There have of necessity been important developments of the plant, and the resources of the works have been greatly augmented. For instance, during the last three or four years the Company have almost doubled their producing capacity, large armour plate machine shops having been added, and electric power adopted for driving the tools. The capacity of the works for

FIG. 6.- OPEN-HEARTH STEEL PLANT; JOHN BROWN & CO., LTD.

armour plates, forgings, shipbuilding materials, and railway plant of all descriptions. The manufacture of the last-named articles had vastly increased, and at this time the Company produced enormous quantities of steel rails; their weldless steel tyres also found a ready and expanding market. Similar enterprise was shown in regard to marine work. A special press was laid down in 1879 for flanging boiler ends; and as soon as the Siemens open-hearth system of making steel was introduced, furnaces were put down, and in addition to the supplying armour has been increased to about 10,000 tons per annum; and it is of interest to learn that during the last 10 years armour has been constructed for 50 British warships, and for naval ships for Japan, Russia, Spain, Norway, Sweden and Holland.

Although we are dealing principally with the Sheffield works, it may be mentioned that the fact that the Company make many of the requisites for warships and merchant steamers, armour plate, boiler material, flues, tubes, engine shaftings, and forgings generally, led the

management to acquire the Clydebank shipbuilding and marine engineering works, which, during their history of half a century, had acquired a world-wide fame for warships, Atlantic liners, and merchantmen of all classes.

JONAS & COLVER, LIMITED, was founded by Sir Joseph Jonas, J.P., the present Lord Mayor of Sheffield, in 1870. In that year Mr. Jonas, as he then was, commenced business at the Continental Steel Works, Attercliffe, where he was joined some three years later by Mr. Robert Colver, a native of Sheffield, who has since been Master of the Cutlers' Company, and also been placed upon the Commission of the Peace. The style of the firm thereupon became Jonas and Colver. The two partners were at first in a comparatively small way of business, and the output was limited; but with the increasing demand for steel trade began to expand, and extensions became necessary to keep abreast of the orders which came pouring in. The Continental Works were enlarged, while the firm also acquired the Universal Steel Works and the Pilot Works, and began operations upon a much larger scale, not only increasing their steel production, but entering upon other branches of manufacture. Since that time the history of the business has been one of continual progress, and about ten years ago all three works underwent important alterations and improvements, while further extensions are being carried out at the present time. The business is now a limited liability undertaking, and the Board includes, in addition to the two original partners, M. C. A. Hahn, who is also Secretary and responsible for the general management; Mr. B. W. Winder, a practical man and an inventor; Mr. W. T. Beesley, whose own works were absorbed by Messrs. Jonas and Colver; and Mr. Robert Jonas, son of the senior partner.

At the Continental Works attention was at first confined to the manufacture of crucible steel, and the number of furnaces soon had to be increased. Some years later the firm acquired furnaces for the production of Siemens-Martin steel, and only recently they purchased some seven acres of adjoining land, upon which they are erecting four more Siemens furnaces, each of a capacity of 25 tons. A large area of ground has been also secured so as to allow for further large extensions in the future. At these works is produced steel for light and heavy ordnance, for all kinds of engineering purposes, for turning rolls, special magnet steel, double and single shear

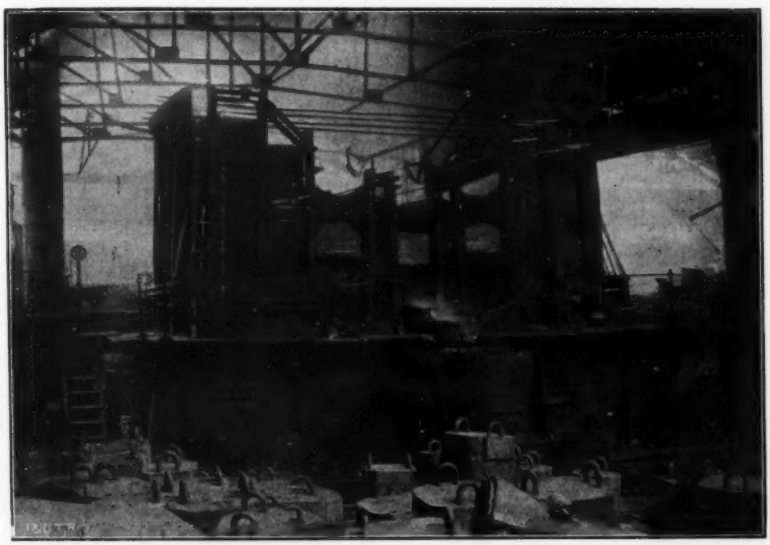

FIG. 7.—SIEMENS DEPARTMENT, SHOWING LADLE IN POSITION FOR TAPPING FURNACE; JONAS & COLVER, LTD.

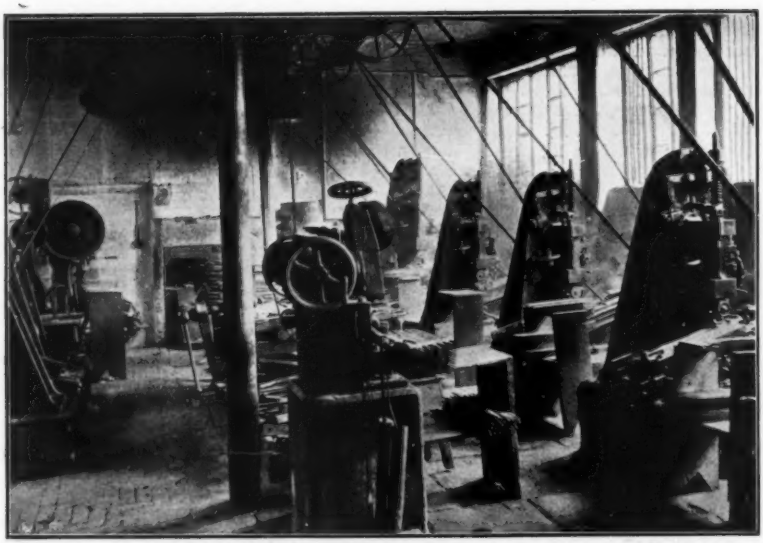

FIG. 8.—CORNER OF FILE CUTTING SHOP; JONAS & COLVER, LTD.

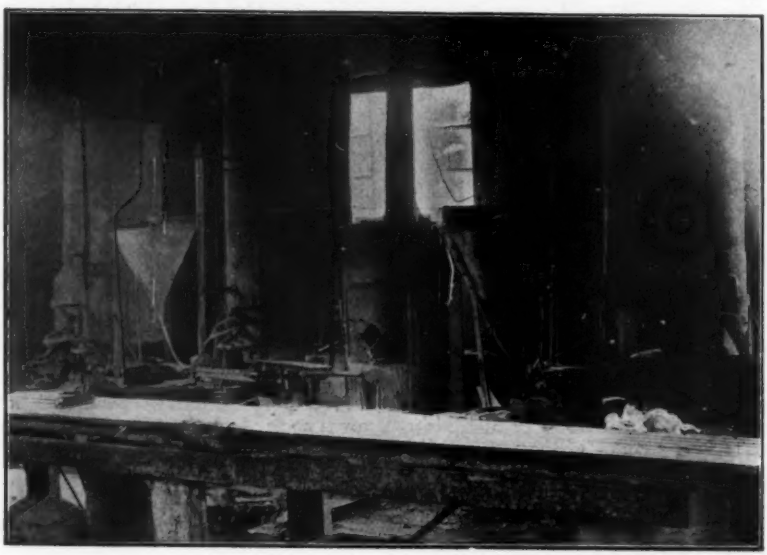

FIG. 9.—SAND BLAST APPARATUS FOR CLEANING FILES; JONAS & COLVER, LTD.

steel, and, indeed, steel for practically all purposes, including high-speed tool steel, the firm having dubbed their brand the "Novo." In connection with the engineering shop is a room set apart for testing steel. Here is a specially constructed high-speed lathe driven by a motor, and containing an indicator which shows exactly the power used with every kind of steel in connection with various methods of cutting. Close by is the magnet testing room, the chemical laboratory and other offices. From time to time Messrs. Jonas and Colver have had to extend their premises and increase their plant to meet the demand for wire Here are carried on the processes of the cold rolling of steel for watch and clock springs, electric bells, and similar uses, as well as drawing steel wire. Employment is found for about 350 men, and the weight of steel produced is over forty tons per week. A complete suite of new offices for the clerical staff is in course of erection here also.

The Pilot Works furnish employment for about 100 men. These works are devoted to the manufacture of tools of all kinds, of saws from the large circular to the tiny fret saw; roller bars, knives for all sorts of food-preparing machinery, knives for bookbinders, tobacco dealers,

FIG. 10.—CRUCIBLE STEEL FOUNDRY; JONAS & COLVER, LTD.

and steel for cycle and motor builders. The annealing furnaces were constructed after the designs of Mr. Winder. In connection with the present enlargement of the Continental Works a complete suite of commodious offices are in course of construction for the clerical staff, which numbers considerably over fifty. The works with the new extension will cover an area of about fifteen acres, and employment is found for 600 to 700 men. When the buildings that are being erected on the adjacent six acres of land are completed, that number will be increased.

The Universal Steel Works are under the management of Mr. W. T. Beesley. and for other cutting plant, as well as knives for mowers and reapers. Sir J. Jonas (a native of Bingen-on-the-Rhine) and Mr. Colver are also partners in a thriving concern situate in the Black Forest, Germany. There they work up cold rolled steel, supplied by their firm in Sheffield, into clock springs, electric bells, and other similar articles.

Fig. 8 is a view of a corner of the file-cutting shop, and Fig. 9 shows the sand blast apparatus for cleaning files. This apparatus is used for two purposes, the first being the cleaning of the files after hardening. All files before hardening are coated with a paste of carbon and suet,

so as to protect the teeth from the action of the fire. When hardened the substance remains on the file and has to be cleaned off, or, as it is generally called in the trade, scoured. Formerly this was done by women using a stiff scouring brush and wet sand, and was an exceedingly rough and dirty process. It is now done by driving on to the file a strong blast of steam and sand, which does the work much more thoroughly and more quickly. The second use of the sand blast is to throw steam and sand on the file at a certain angle to sharpen the teeth.

Fig. 10 shows a portion of the crucible steel foundry, including one of the first furnaces erected by the firm. In this furnace an ingot of best tool steel can be cast up to 4 or 5 tons weight. An interesting department of these works is the roll turning shop, one of the most important adjuncts to a rolling mill. The restrictions as to size are now so stringent that the greatest accuracy has to be observed; in some sizes only the 1-500th part of an inch is allowed as margin.

Malleable Iron Foundry of the Hardy Patent Pick Company, Limited.—The mining tool works of the Hardy Patent Pick Company, Limited, at Heeley, Sheffield, now constitute a great manufactory, with many branches and ramifications, turning out a variety of implements and machinery in large quantities. They originated with an American named Hardy and a Canadian named Stayner. Mr. Hardy had ideas on the subject of picks, and decided to bring them to England. Crossing the Atlantic some thirty years ago, he fell in with Mr. Stayner. The two became friendly, and eventually went into partnership. On their arrival in this country they were but coldly received by manufacturers and capitalists, with the result that they both hired a shed on the premises of the old Stable Works, Sheffield, and commenced in a very small way to make their own picks, which soon began to attract favourable notice among colliery owners and to be in demand. The advantage of the implements they made was that the shaft could be fitted to any shape or size of

Fig. 11.—Malleable Iron Foundry; Hardy Patent Pick Company, Ltd.

head, so that a miner who wanted half-a-dozen different heads was not under the necessity of taking down into the pit that number of complete picks. From the nature of the original business done the enterprise took the name which it still retains, although its manufactures have multiplied exceedingly, not only in quantity, but variety. The tool department, however, is still one of the most prominent features of the undertaking, and its productions are well known in the mining world. It consists of a handle-making shop and a grinding shop, together with warehouses and minor buildings. The handle-making shop is equipped with saw benches, lathes, bending machinery, and all tools necessary for the manufacture of shovel, pick, and all other handles. The grinding shop contains grindstones and belting frames for grinding and glazing all descriptions of shovels, hoes, hammers, and other tools, while in the warehouses is a very large stock of shovels, coke forks, agricultural forks, plantation hoes, axes, rock-boring machines for hand and power, picks, hammers, wedges, crow bars, and, in fact, every description of mining, contractors', quarry, and agricultural tools. The works also include an extensive malleable iron foundry, for the manufacture of all kinds of malleable iron castings used in the Company's specialities. It is well equipped with moulding machines, annealing ovens, and all machinery necessary for this work. We publish an illustration of this foundry in Fig. 11.

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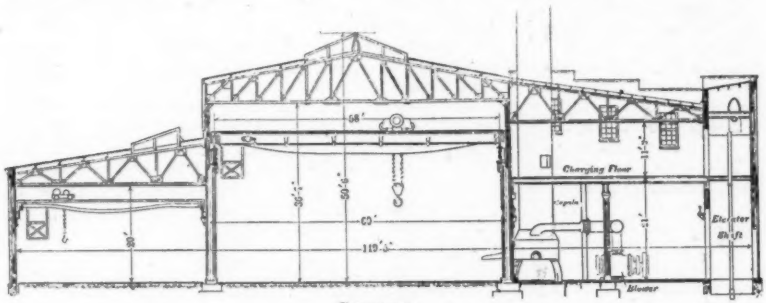
NEGOTIATIONS have been completed for the fencing of two acres of ground on the Kincaid estate, Kirkintilloch, for the erection of engineering works. The lessees are Messrs. Andrews & Cameron.

A LARGE AMERICAN FOUNDRY.

THE INTERNATIONAL PUMP COMPANY have recently completed a new works, near New York, U.S.A., which is by far the largest in the world. The buildings will accommodate about 6,000 workmen and were erected at a cost of more than £400,000. One building alone, the machine shop, covers over 130,000 square feet of ground, and the total floor area of the plant is 18 acres. The following acccount of the foundry equipment is not without interest :—

The Pattern Shop.

There are in reality three pattern shops, divided into as many different rooms, each 150 by 75 ft. About 75 men are employed in these shops. The equipment includes six band saws, two of which tilt in either direction. There are three surface planer, one carrying 30-in. knives capable of planing stuff of any thickness and fitted with a table which tilts 20 degrees in either direction. Of lathes there are five of the regular style and four post lathes. There are two dozen trimmers, the largest of which is capable of cutting a piece of wood, 8 by 20 in.; two thickness planers, which plane stuff 20 in. wide and 6 in. thick. Glue is supplied by six Hadaway electric heaters. Metal patterns are fitted in the machine shops, a space of about 40 by 60 ft. being devoted to this work. Twelve men are regularly employed in the pattern department. For the storing of patterns a building 500 ft. long, 75 ft. wide, and four stories high is provided. Patterns are stored upon shelves supported by metal posts and adjustable brackets; metal patterns are arranged upon iron shelves and racks of



SECTION.
THE IRON FOUNDRY OF THE INTERNATIONAL PUMP CO.

special design. A card index gives at once the location of any pattern in the building. The construction is of the slow burning variety of brick and wood. The sprinkler system for fire protection is installed on all floors.

Main Foundry.

The main foundry occupies a building 600 ft. long by 100 ft. wide. The space is divided into a centre bay, 60 ft. wide and two side bays, each 40 ft. wide. In the centre bay there are two 30-ton and two 20-ton bridge cranes operated and driven electrically. In the side bays there are four 10-ton cranes all electrically driven and operated. The main foundry contains, besides these, five 15-ton wall jib cranes also electrically operated. Metal for the main foundry is supplied by two cupolas of 84 in. shell, and 72 in. diameter inside of the lining, the capacity being 36 tons per hour. The air is supplied by rotary blowers driven by 75-h.p. electric motors. The main foundry has 5,000 square feet of core oven surface. The doors of the oven are equipped with roller shutters. The ovens are of the Company's own design and are constructed of brick; they are fired by either coke or gas.

The work done in the main foundry includes loam, dry sand, and green sand operations; it is used only for large pieces. About 350 men are regularly employed in this department.

A novel feature in the foundries of the firm is the equipment for cleaning castings. In the main foundry a space 140 ft. wide by 75 ft. long is provided with a cellar or basement over which the main floor is built of concrete and steel construction. In this floor there are 3 ft. by 5 ft. openings placed at intervals. These are covered with iron gratings of bars 1 in. by 3 in. and separated by 1½-in. spaces. The castings are placed upon or near these gratings and the sand removed from the rough pieces is allowed to drop through the gratings into the cellar below. A belt conveyor delivers the material to an electrical separator, the sand being then conveyed to a car on a track outside and the shot iron to an elevator which deposits it in a car which returns it to the cupola.

The object of this arrangement is to provide a clean floor space for working, allowing all hot sand from castings to pass out of the way and prevent the annoyance to workmen caused by heaps of sand and rubbish. All large loam jobs are also taken upon this floor and knocked down, the material going to the cellar and afterwards being separated and brought back to the place designed for it.

The cores for the main foundry are prepared in a room 75 ft. long and 40 ft. wide. Cores up to 500 and 1,000 lbs. each are prepared in this room, the work being done by women, about 25 of whom are employed.

A 30-in. gauge track system with turntables gives access to all principal parts of the shop. The sand storage building, 250 ft. long and 35 ft. wide, forms a part of the main foundry. This building is divided into bins for the different grades of material required. The sand is delivered in drop-bottom cars, dumped into a pit, elevated to the top of the sand sheds by a bucket chain conveyor and deposited on a 24-in. belt conveyor, which runs the entire length of the building and is provided with an automatic dumping device which can be set to discharge at any point.

In the centre bay are three large moulding pits, each 15 ft. by 30 ft. and 15 ft. deep, in which the larger pieces are handled.

Machine Moulding Foundry.

The moulding machine foundry is 400 ft. long and 65 ft. wide and has a sand cellar or basement the entire length of the building. The foundry is divided into floors, 12 ft. wide by 30 ft. long, with a gangway 5 ft. wide along the centre. Each floor section is equipped with a travelling crane of one ton capacity, electrically operated and with hand travel, so that each operator has the exclusive use of his own floor space and his own crane. In the centre of each floor space is a grating 3 ft. wide and 20 ft. long. Each section is equipped with moulding machines of the various types and provided with a bucket elevator.

As the moulds are taken from the machines, they are set down as near the gangway as possible, where they are poured off by a separate gang of men, and as soon as cool enough the castings are dumped, when they are disposed of by another gang of men. The sand passes through the grating to the cellar below, where it is cooled, tempered, and shovelled into the conveyor which runs from the cellar to the moulding floor, and deposited on a bench before the moulding machines.

The object of this system, which is due to the ingenuity of W. L. Prince, superintendent of the foundries of the International Steam Pump Company, is to reduce the floor space required for a given amount of work. As the cupolas melt

during the entire day, the moulds are poured as soon as finished, and the castings dumped and gotten out of the way with a minimum loss of time. To illustrate what may be done with this system, Mr. Prince stated that one machine upon a floor of the dimensions given has produced 100 flasks a day, the size of the flask being 21 ft. square. To accomplish the work performed in this foundry in the old way would require a floor space at least five times as large. The system reduces the size of the foundry, it brings the work closer to the cupola, allows the mould to be cast before dampness can be absorbed by the cores and has accomplished what the foundry business has long been seeking—a continuous founding process without the expense of an elaborate conveyor system, which requires the services of as many machinists as the moulders which it serves. The system here described provides an industrial conveyor for each operator, so that if one is out of order the remainder of the shop remains unaffected.

There are two cupolas in the machine moulding foundry, each 60 in. in diameter of shell and lined down to 48 in. One cupola is operated in the forenoon and the other in the afternoon. This lengthens the life of the linings, which amply makes up for the additional fuel required. The air is supplied by rotary blowers operated by independent 50-h.p. electric motors. The metal is conveyed to the floor sections by ladles mounted upon trucks.

A room at one end of the building is devoted to the preparation of cores. In this room all cores used in the building are made by girls, the cores ranging in weight from one ounce to 1,000 lbs. At one side of this room are sixteen Millet core ovens and four brick ovens, 10 ft. by 20 ft.; these are supplied with roller shutter doors and with special cars fitted with roll bearings. The fuel employed is either gas or coke. Under the core shop all the sand for the foundry and core room is stored. Here also the operations of mixing are performed, the mixing being accomplished by mechanical sand mixers of the revolving cone type, another invention due to Mr. Prince. The prepared sand is conveyed to the shop above by bucket elevators.

Cleaning Room.

Annexed to this building is the cleaning department, 200 ft. long by 60 ft. wide. The building contains a 5-ton crane, electrically operated and travelled, and all the latest and up-to-date cleaning appliances. There are four sand blast rumblers and two sand blast rooms, each 20 ft. square, with gratings through which the sand is drained by an exhaust system into settling tanks, afterwards to be returned to the sand blast apparatus. In addition there are six Sly rumbling barrels, each 60 in. in diameter and 70 in. long, driven by electric motors by means of shafting. Chipping is performed by pneumatic chippers, transverse connections for air pressure being provided. A Rockwell annealing furnace, in which small parts are annealed, is in the chipping room. Castings are taken from the cleaning room by standard gauge cars and hauled directly to the machine shop. At the present time about 75 men are employed in the machine moulding foundry and about 30 in the chipping room. About 25 girls attend to the operations of the core shop.

Brass Foundry.

The brass foundry is located at the end of the foundry yard, between the machine moulding and the main foundry. The building is 200 ft. long by 100 ft. wide, and is divided into a centre bay and two side bays. A 3-ton travelling crane commands the floor of the centre bay, and the side bays are equipped with a Coburn trolley system. For melting metal there are five Schwartz furnaces, one of 4,000 lbs., two of 2,000 lbs., and two of 1,200 lbs. capacity for each heat, and three No. 150 and three No. 200 crucible furnaces. Only the small parts are actually cast in the brass foundry, the large pieces being handled in the main foundry, whither the molten metal is transferred by the industrial track system. Brass castings weighing as much as 5 tons each are produced. The brass foundry has moulding machines of various types; castings are cleaned by the sand blast method and by water barrel rumblers, pneumatic chippers and grinders with carborundum wheels. All refuse is put through grinding mills and electric separators.

The furnaces are operated by crude oil or gas. At the time of writing fuel is drawn from tanks of crude oil stored under ground in the yard, but a gas plant is under construction and it is expected that this fuel will be used exclusively.

The building has metal vaults, 20 ft. by 20 ft., where all stock is stored. Over each bay is a galley provided with an elevator, which receives material returned from the machine shop. It is here separated into its component parts and put into bins, whence it can be delivered by the storekeeper to the furnaces as called for. About 35 men are at present employed in the brass foundry.

Cost System.

The method of keeping the cost accounts in the foundries of the International Steam Pump Company possesses several original features and many advantages. The accounts are divided into "Green Sand Castings," "Dry Sand Castings," "Loam," "Machine," "Cleaning," "Chipping," "Expense," "Moulding," and "Iron Casting Production." The tabulated accounts show the total cost per pound, so that the management is able to tell from month to month the exact cost per pound of product for each operation. Tabulated accounts are kept of the daily productions, daily pay roll, productions per moulder, productions per helper, number and percentage of poor and good castings, and cost of patterns per pound. By means of this method it is possible to determine at a glance any increase or decrease in cost and to detect at once the cause. The method of keeping the separate labour accounts is simplified by an ingenious numbering device. Thus the men in one department or room are numbered from 1 to 100; those in another department from 200 to 300, and so on. The names are easily classified by reference to the numbers. This cost system is also due to Mr. Prince, the superintendent of the foundries.

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PIG-IRON AND ITS SPECIFICATIONS.

By Ernest Wheeler.

The specifications for pig-iron which have been drawn up by the British Thomson-Houston Company, of Rugby (see Journal, September issue, 1904). form a bold attempt to introduce into this country the methods of classification which are in use in America.

The subject has received much attention, but it has been felt that the conditions of working in Britain are so essentially different from those in the United States that to adopt rigid specifications might hardly be fair to the makers of the pig-iron. It was also thought by some that consumers would not benefit by such alterations in trade practice, and the matter is certainly a many-sided one which needs very careful consideration. Up to the present few makers can be persuaded to sell by analysis, and it is the custom, even if an analysis be given, not to guarantee it. Very often the figures given do not agree with those obtained by analysing the iron supplied.

There is certainly need for some kind of specifications of British pig-iron, and when such have been adopted it is very probable that the industry will be more efficiently handled. At present the quality of pig-iron is judged very largely by conservative and out of date methods. For instance, there are still many who judge solely by the appearance of the freshly fractured surface of the iron.

This method may be used to a certain extent if the iron is known to the person judging it; but, at the very best, it is most deceptive and very unscientific. Again, others judge largely by name, and the proverb "Give a dog a bad name and hang him" holds just as good in the iron trade as elsewhere; while certain other brands are supposed to represent irons of infallible quality, which, like a well advertised medicine, can be used to cure any and every sort of ill known to the ironfounder. The injustice of this procedure is apparent, and it is evident that some more definite and scientific system of grading should be available.

In the recently published specifications of the British Thomson-Houston Company we may take it that the limits laid down are those which have been found by practical experience to be most suitable for electrical work, where a very pure cast iron is often a necessity if the best results are to be obtained.

The influence of the different impurities upon the electrical conductivity of cast iron is apt to be very detrimental if these elements are not kept within proper limits. Therefore, these specifications may perhaps be regarded as more special in their nature than is required in the ordinary run of foundry work. One of the chief difficulties, however, in making specifications for pig-iron is to so frame them that any ironfounder can select from them suitable irons for the work he has in hand.

The only really satisfactory way would be for some authorised body, such as the British Foundrymen's Association, to make a thorough investigation of the matter with a view to drawing up some standard specifications which would be accepted by the whole trade, without dissension, as far as possible.

The question has also been under consideration by a committee of the London Metal Exchange, and they have made a laudable effort to solve the question in a practical manner.

The following extract from their contract form for standard foundry pig-iron, which came into force on the 1st of January this year, shows what is being

done at the present time with regard to this important subject:—

	No. 1 Grade.	No. 2 Grade.	No. 3 Grade.	No. 4 Grade.
Silicon ...	2.50-3.50 not over	2.50-3.50 not over	1.75 3.00 not over	1.50-2.50 not over
Sulphur ...	.035	.045	.060	.080
Phosphorus	1.65	1.65	1.65	1.65

After stating that sellers have the option to deliver warrants for certain well-known brands, the form states that sellers may also deliver warrants for "any other irons, the make or brand of which has been passed by the committee and conforms to the standard analysis" (given above).

"Under this category each 500-ton parcel must be sampled under supervision of one of the recognised analysts, by drilling ten pigs in every 100 tons, half-way through at the side of the pig and about 6 in. from the end. Three samples shall be taken from the drillings and one sent to each of two recognised analysts, and, if they be unable to agree, the third sample shall be sent to a third recognised analyst, chosen by the other two, who shall determine the analysis, and whose report shall be final and binding."

We thus see what is being done to make our methods of purchasing more fair to both the buyer and seller.

The whole subject is one of vital importance and worthy of much serious attention.

If the efforts so far made result only in a slight tendency towards the production of more uniformity in the quality of our pig-iron, then the labour will not have been in vain.

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MANY of the Scottish shipbuilding firms are at present extensively equipping their yards with pneumatic tools. Mains of great capacity for the transmission of compressed air are also being laid down in a number of yards, and in others which have already made such provision orders are being given for air-compressing plant of great capacity. The Grangemouth and Greenock Dockyard Company have placed an order for 50 Haeselder pneumatic tools with Messrs. J. Macdonald & Son, of York Street, Glasgow. The London and Glasgow Engineering and Iron Shipbuilding Company have also ordered from Messrs. Macdonald 10 pneumatic drills of the "Thor" type, for which they are agents. Quite recently, also, Vickers, Sons, & Maxim, Limited, of Barrow, have placed orders with Messrs. Macdonald for upwards of 50 tools.

DEPARTMENT COMBINATION IN A FOUNDRY.

THE departments of a foundry are like the mechanism of a watch: each part is essential to the proper working of the whole. And as in a watch it is necessary that every part should perform its function correctly in order that accuracy may be obtained, so in a foundry there must be a thorough understanding amongst the different departments, and those who handle the work in each grade, from its inception to completion, should have a common object in view. It is only if this state of matters exists that foundry work can be executed in a successful and economical manner.

The departments can only be considered successful if, as the work proceeds, the links are added to the chain perfectly and with economy, and if those who have preceded have shaped their course with a view to the requirements of those who follow.

It is in the

Drawing Department

that the wishes of the customer first take their shape. Here it is also that a conception of the perfect finished article is formed. The skill of the draughtsman is of paramount importance all through the work; for he is in reality the Alpha and Omega of it. He provides on paper the idea of what the finished article is to be, and the finished article ought to be in metal the replica of what he has drawn. While his primary duty is to design the article which the customer wants, that duty ought to be performed with the least expense to his employer. It is essential, therefore, in a thoroughly competent draughtsman that he should be able to detect and provide for any trouble or defects which are likely to arise in the pattern, moulding, or fitting shops; in fact, to arrange the details of his work in such a way that the desired object will be attained with the least possible trouble in the works and at a minimum of cost. To do this he must have a thorough understanding of all the different branches, and be conversant with the technical difficulties of each and how best to overcome them. This knowledge can only be obtained by a practical training in all the branches. If the draughtsman has had the advantage of such a training, he has acquired information which must make him more equipped for his profession than another who has only studied the other branches in theory; for the practical man

will be able to detect at the outset the difficulties which are likely to arise as the work proceeds. Again, he may, before any expense is incurred, find that difficulties which present themselves to him cannot be overcome, and be able to suggest to a customer some alternative which may suit the requirements of the case just as well, and so save time and money both to the customer and to his employer.

The Pattern Department.

The duties of the pattern-maker are probably as important as those of the draughtsman; perhaps there is no other branch of the foundry trade on which the success of the other departments depends more than that of the pattern department. The pattern-maker generally meets with more difficulties than any of the other tradesmen connected with the foundry. Not only has he to be thoroughly conversant with his own trade, but he must understand the object and intention of the draughtsman who precedes him, and provide for the needs of the moulder who follows; his value, in fact, as a workman, must be measured by his comprehension of the objects of the former and of the requirements of the latter. If he follows both intelligently, he will prove himself a most valuable asset to his employer. In many foundries the class of work undertaken does not necessitate the employment of a draughtsman. If this is the case, many of the difficulties which arise in the ordinary course of business find their way to the pattern shop for elucidation; and the pattern-maker is called upon to exercise not only his practical knowledge, but often to clear up points which are outside his province. A pattern-maker in such circumstances has an opportunity of acquiring knowledge of a very valuable and varied description, which will always stand him in good stead.

The Moulding Department.

The success of the whole foundry depends upon this department. It is here that the realisation or perfecting of the work takes place; and it is here also that the ability or otherwise of those who have previously handled the work comes to light. Whether everything has been done by the draughtsman and by the pattern-maker to facilitate the work of the moulder is now brought to view. Often a great deal of precious time and valuable work is wasted by the moulder in order to get a pattern out of the sand; perhaps through no provision having been made for rapping or drawing the pattern, or through there being insufficient draw, or some parts made fixtures which should have been loose, while another common mistake is the making of the pattern in one piece when it should have been made in two or more. Sometimes, no doubt, these mistakes arise through ignorance on the part of the pattern-maker; more often, however, they occur through this department attempting to save itself time and trouble. It is not in the interest of the employer that one department should prepare a piece of work a certain way in order to save trouble in that particular department, and to find that the work, when it reaches another department, causes no end of trouble, extra labour, and very frequently bad castings.

The Fitting Department.

This department is a very important one where the business carried on is of a constructional nature. Not only must the component parts have been accurately made, but they must be properly fitted together. Here, again, we find a branch which is entirely dependent on the consideration of those who have previously handled the articles, and whose duty it was to make the necessary provision for the fixing of the separate parts correctly by providing the necessary fitting strips, etc., in order that the cost of fitting may be kept down to a minimum. There are other departments which we might mention, but we think the above sufficiently illustrate what we desire to draw attention to: that if the work is to be done quickly, accurately, and economically, all the departments must work in harmony and with a view to the saving of money, time and labour.

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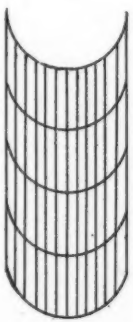
THE directors of John Brown & Company, Limited, have for some time had under consideration the desirability of entering upon the manufacture of ordnance, and, with this object in view, negotiations are in progress for the acquisition of a half-share in the Coventry Ordnance Works of Cammell Laird & Company, Limited.

MR. E. WHITE, of the Windsor Works, Redditch, has acquired the patent rights of Mr. C. W. Coleman's invention of pattern plate apparatus, and Mr. White will now manufacture the apparatus at Redditch. Mr. Whittleton, of 9, Fenchurch Street, London, E.C., has been appointed sole agent for London and the South of England for the sale of this apparatus.

CORES FOR MOTOR CYLINDERS.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Having myself been employed in the internal combustion engine trade for several years, some of which have not been altogether void of such troubles met with by T. P. & Company, Limited, I find that a large percentage of such troubles arise directly through the use of sand of a too argillaceous nature, which in itself is totally unfit for cores such as ports, jackets, etc. But in all casting processes much of the success of the operation depends on the skilful manipulation of the core-maker and moulder, the due admixture of materials



with that degree of porousness necessary for the escape of the gases as they are generated by the fluid metal. I offer the following advice to T. P. & Company, Limited, as a definite solution of their difficulty, and which will be found to be more economical in the long run than a 75 per cent. dead loss. Get some sand such as supplied by the Doncaster Sand Company, purchasable in quantities at a fairly low cost, and which undoubtedly is the finest in the kingdom for all clasess of internal work. I also recommend the use of a core iron, similar to sketch, made to suit size and shape of core-box, say wire, $\frac{1}{16}$in. thick, crossed as shown, then tied at joints with fine wire and soldered with tinman's solder; they will then have a strong rigid iron, which at the same time permits of easy removal. Use wax wire vents, of which there are plenty on the market, $\frac{1}{16}$in. thick. Use these freely, laid longitudinally, then lay one or two more as needed transversely, so as to concentrate the whole of the air on the most suitable place or places of egress. Use the sand as mentioned in proportion of 5 parts new to 2 parts old and horse droppings, dried, then riddled, one shovelful to about a barrow-load of sand; place the whole of same in the mill and mill for a few minutes. The cores should not be placed too close to the fire, but should be made in numbers to allow the wax to thoroughly dry out, as no core should be used when saturated with wax. If T. P. & Company, Limited, will give this a trial, I venture to think they will admit at the end of a month they have found something new, yet very old, and their trouble with blown castings having disappeared, are thereby enabled to produce the castings in question with the same degree of certainty as with ordinary work.

Yours, etc.,
CHARLES E. ALLEN.

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THE FLOATING OF SOLID METAL.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—The above title may not inaptly suit for the query which appeared in the April issue of your journal, wherein "Inquirer" asked:—(1) If it was the case that solid metal will float in molten metal, and, if so, why? (2) Is it the case that all fusible bodies or liquid metals maintain in buoyancy their own solid bodies?

I notice in this month's issue (September) we have from Mr. C. E. Allen an affirmative "that solid metal will float in molten metal." The term as used here is somewhat ambiguous to the writer, unless it be that fluid cast iron will sustain in buoyancy solid cast iron. Now, if this hypothesis be correct, is it not a little difficult to see wherein the greater density or specific gravity referred to by Mr. Allen in his answer comes in? It is known to founders in cast iron or in any other metals that shrinkage inevitably reduces bulk by passing into the solid mass, thus creating greater density bulk for bulk with fluid metal. Therefore, according to the law of floating bodies, we have in the floating of metal, as enunciated here, a positive contradiction of terms by the lesser density, which is the fluid metal, maintaining in buoyancy the solid. Assuming then that the explanation given here be a correct one, much scope is given for those of such a turn of mind as Mr. Allen, to whom many will doubtless be indebted for his intelligent reply to "Inquirer."

Regarding the second part of query that has been referred to in the opening paragraph of this letter, I am sorry to say that my limited experience in metals of a varied kind is not so great as to enable me to say whether or not "all fusible or liquefied metals" maintain in buoyancy their own solid bodies.

Trusting to hear more of this interesting subject.

Yours, etc.,
SUBSCRIBER.

PRESSURE.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—I observe at p. 388 of your September issue Mr. C. E. Allen replies to "Novice" about his query on the above subject.

Mr. C. E. Allen says "the fluid strain or pressure on moulds while being cast is not determined by the thickness of the walls of the mould, but by the surface area and the height of the flow gates." I should like to know what the thickness of the walls of a mould has got to do with pressure? Absolutely nothing whatever; but the same cannot be said of the metal.

I am afraid if Mr. Allen would look again at p. 274 (July issue) he will see that "Novice" asks what difference of pressure there is on the walls of a mould whose metal is, say, 1 in. thick as against 2 in.? It will be noticed that Mr. Allen only deals with bottom surface and vertical height, no reference being made to side pressure, which is the kernel of the question. Perhaps, when Mr. Allen has this point brought before him, he will be able to give us some light on side pressure, and judging from his able correspondence in your journal previously, I trust I am not asking too much.

Yours, etc.,
FOUNDRYMAN.

THE shareholders of the York Engineering Company recently met to receive the report of the liquidator on the voluntary winding up of the Company. There is, after the payment of sundry debts and charges, £183,562 to be distributed among the shareholders. The paid-up capital amounts to £70,196, so that the distribution is equivalent to 26½ per cent.

BLOW-HOLES IN CASTINGS.

By J. E.

A short while back this question was brought forward by Mr. J. A. Phillips in the "Mechanical World," and a short discussion followed, but nothing like the discussion that ought to be upon a subject so very important, so very great, so all-pervading. Break any casting you like, and you will almost always find blow-holes. What are we to do to rid ourselves of these troublesome defects, seeing that opinions differ so much? In the discussion referred to above, one gentleman tells us that "blow-holes are caused by venting." Another tells us that he "cannot quite reason why air should be drawn into moulds through vent-holes." Another says that "the very act of pouring a mould tends to create blow-holes, as, at the time of pouring, there is an agitation set up of more or less severity, which creates blow-holes." Another says "the fault lies entirely with the furnace-man, because, being very unintelligent, he puts the material on like a machine, regardless of quality or condition"; while another says that "all impurities—blow-holes included—will certainly liberate themselves while the metal is flowing from the cupola to the ladles, and certainly before the metal is poured into the moulds, providing the metal is in good condition. This is rather borne out by Mr. Phillips' statement of the fact that "better castings are obtained when the metal is very hot and thinly fluid." I think that if the blow-holes or sulphur bulbs do not liberate themselves while the metal is flowing from the cupola, or from the ladle into the mould, they will not do so after.

Another gentleman, in this same discussion, says "at the end of each tap the slag is let run into the ladles, and is a gas producer, and continues to generate gas in the mould." This statement seems a little strange. We do know what happens if we let a little slag into the mould, for we can see the result in the casting. The slag can easily be picked out, and leaves the casting—at the spot from where it has been taken—dirty and ragged—nothing like a blow-hole; but we do not know that slag let into a mould will cause blow-holes. However, there is much to be learnt yet, and it may be right after all. But I do think that this question is so very important that a good discussion from all points would be beneficial, especially from working moulders, who have seen blow-holes in all shapes and sizes; and if they would only write their experiences and ideas they will be doing a good thing.

TRADE TALK.

CLARKE, CHAPMAN & COMPANY, LIMITED, have established a branch at 21, Mountstuart Square, Cardiff.

THE average realised net price at works of Scottish manufactured iron for July and August last was £5 16s. 3.13d. per ton.

THE MOSS BAY COMPANY have just let contracts for a new railway sleeper mill of double the capacity of their present one.

A NEW rolling mill and furnaces have been added to the plant at the Clydebridge Steel Works, Cambuslang, Scotland.

IT is stated that the new industry which is to be established at Hull by an American firm is connected with the light iron trade.

THE JONES SYNDICATE, of London, etc., have placed an order with Fodens, Limited, of Sandbach, for 70 motor wagons.

MR. C. HUMPHRIES, who traded as the Midland Foundry Company, Great Bridge, Tipton, Staffs., has been adjudged bankrupt.

MESSRS. E. BENNIS & COMPANY, who recently removed their business from Bolton to Little Hulton, are about to extend their works.

SUPER-REFINING METALLURGISTS, LIMITED, has been registered with a capital of £10,000, in £1 shares, with offices at 27, Old Jewry, E.C.

MESSRS. R. JONES and J. WALTON, ironfounders, Nelson, Lancashire, trading under the style of Jones & Walton, have dissolved partnership.

THE GLASGOW NUT AND BOLT COMPANY are establishing new works at Gateshead, having lately acquired a considerable area of land in the vicinity.

SHAW & GASKELL, LIMITED, of Chapman Street, Hull, has been formed to carry on the business of ironfounders, etc. The capital is £20,000, in £1 shares.

AT the engineering premises of Messrs. Shand & Robertson, Kilsyth Road, Kirkintilloch, recently, a fire broke out, doing considerable damage.

MR. P. J. MITCHELL, engineer, has changed his offices from 52, Queen Victoria Street, to 31 and 32, Budge Row, Queen Victoria Street, London, E.C.

AT the Blaenavon Works, Monmouthshire, which have been idle, the directors have decided upon extensive improvements in the present plant.

MESSRS. F. H. SMITH and C. F. BILL, engineers, etc., of Datchet, Bucks, trading under the style of F. H. Smith & Company, have dissolved partnership.

THE Jarrow brand of pig-iron has been admitted as a Middlesbrough G.M.B., and may be tendered as implementing a contract for No. 3 Middlesbrough or standard iron.

JAMES NASMYTH & COMPANY, LIMITED, are extending their works at Patricroft, near Manchester, by building another workshop near the famous Bridgewater Foundry.

A FIRE recently broke out in the pattern store and boilersmiths' shop at the South Durham Steel and Iron Company's Works at West Hartlepool. The damage was extensive.

A RECEIVING order has been made in connection with the affairs of Mr. E. Donat, mechanical engineer, Manchester, who traded under the style of Donat & Company.

A SLIGHT outbreak of fire occurred in the engineering works of Scott's Shipbuilding and Engineering Company, Greenock, recently. The damage was only slight.

THE SILENT MACHINE AND ENGINEERING COMPANY, Sheffield, have appointed Messrs. P. and A. Hutchison, 72, Waterloo Street, Glasgow, as their sole Scottish agents.

THE directors of the Rykneild Engine Company, Burton-on-Trent, have decided to close their premises. It is officially stated that the closing of the works is due to lack of capital.

T. W. LAWLEY, LIMITED, are acquiring the business carried on at Plant Street, and at the Central Engineering Works, Oak Street, Old Hill, Staffordshire, by Mr. T. W. Lawley.

THE NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED, contemplate the erection of extensive new works on four acres of land they have recently acquired at Polmadie, Glasgow.

THE average net selling price of No. 3 G.M.B. Cleveland pig-iron for the three months ending September 30 last has been certified at 46s., as against 47s. 0.86d. in the previous quarter.

PALMERS' SHIPBUILDING AND IRON COMPANY, LIMITED, are shortly to carry out a comprehensive scheme of additions to, and improvements at, their extensive works at Jarrow-on-Tyne.

MESSRS. W. F. DENNIS & COMPANY, of Albert Buildings, 49, Queen Victoria Street, London, E.C., have been appointed sole British agents for Les Ateliers du Roeulx le Roeulx, Belgium.

EXTENSIVE structural alterations are being carried out at Messrs. Cammell Laird & Company's Derwent Works in pursuance of a scheme of thorough modernisation of the works.

A DISSOLUTION of partnership is notified in connection with Messrs. J. Petherick and R. Stenner, ironfounders, etc., Tavistock, Devon, who traded under the style of Petherick & Stenner.

ARNOLD & LARGE, LIMITED, have acquired the business carried on at Green Lane, Wolverhampton, by Messrs. Arnold & Large, ironmasters, founders, etc. The capital of the Company is £3,000.

IT has been rumoured that Sir W. G. Armstrong, Whitworth & Company, Limited, are contemplating establishing a branch of their works in Japan. The report, however, lacks confirmation.

THE REFORM CASTINGS, LIMITED, is the style of a company registered to acquire from A. T. Tatham the Bosshardt process relating to the casting of malleable iron and steel. The capital is £15,000, in £1 shares.

RICHARDSONS, WESTGARTH & COMPANY, LIMITED, have just completed their new turbine works and brass foundry at Hartlepool, new iron foundry at Middlesbrough, and the boiler shop extension at Sunderland.

THE STANTON IRON WORKS COMPANY have contracted with the Morley Town Council for the supply of 15-in. cast-iron pipes, the prices agreed upon being £10,401 for straight pipes, and £225 for irregular pipes.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED, have recently secured a contract from the New York, Newhaven and Hartford Railway Company for the supply of 25 single-phase electrical locomotives.

MR. J. A. M'GILVRAY, lecturer in mechanical engineering under the Linlithgow and Stirling County Councils, has established himself in business as a consulting mechanical engineer at 11, West Regent Street, Glasgow.

DOBBIE MCINNES, LIMITED, have removed their London office to 113, Fenchurch Street, E.C. The Company, in connection with their exhibits at the Earl's Court Exhibition, have been awarded a medal diploma.

THE PULSOMETER ENGINEERING COMPANY, LIMITED, of London and Reading, have been awarded a gold medal for their exhibits at the Earl's Court Exhibition this year, as also have Messrs. W. Simons & Company, Limited, of Renfrew.

MR. H. S. MEYER has resigned his position as chief designing and consulting engineer for alternating-current work to the British Thomson-Houston Company, Limited, to establish himself in business in London as a consulting engineer.

IT has been officially stated that the reports of negotiations for the purpose of amalgamating the business of the Moss Bay Hematite Iron and Steel Company, of Workington, with that of Messrs. Cammell Laird & Company, are incorrect.

THE STAR FOUNDRY (BRIGHTON), LIMITED, is the style of a concern formed with a capital of £5,000, in £5 shares, to acquire the business recently carried on at the Star Foundry, Shoreham Road, Portslade, as George Burstow & Sons.

THE BLAKE BOILER, WAGON AND ENGINEERING COMPANY, LIMITED, of Darlington, has been formed to take over the Alliance Works at Albert Hill. Mr. C. Emmott, of Snow Hall, is the Chairman. The Company's works are to be equipped with electric light and with electrically-driven machinery.

THE new main engineering shop at the Birkenhead works of Cammell Laird & Company, Limited, will be over 1,000 ft. long, and will have a height under the travelling cranes of about 120 ft. One machine shop will be 525 ft., and the other 615 ft. long, the smith's shop 270 ft., and a light iron shop 350 ft. long.

THE recent agitation in the Cradley Heath district respecting the sale of the disused Admiralty chains is being revived by the leaders of the operatives in the chain trade in consequence of it having been discovered that large consignments of obsolete chains are being placed on the market in different parts of the country.

TRANTER & HAYCOCK, LIMITED, has been formed with a capital of £2,000, in £1 shares, to acquire the business carried on by W. Tranter, at 239, Bradford Street, Birmingham, and to carry on the business of brass founders and workers. The registered office is at Newton Chambers, Cannon Street, Birmingham.

Messrs. J. E. H. Andrew & Company, of Reddish, Stockport, are supplying six power-gas engines, each of 120 b.h.p., together with a Mond gas-producing plant, for installation at the Union Iron Works, West Gorton, Manchester, of Messrs. Brooks & Doxey. Messrs. Andrew are also supplying two double-cylinder type engines, each of 210 b.h.p., for driving alternators at the works of the Coalbrookdale Company.

An interesting stage in the history of the great works at Elswick, of Sir W. G. Armstrong, Whitworth & Company, Limited, has been reached during the month in the "coming of age" of the Elswick Shipyard. It is just twenty-one years since the yard was formally opened. Curiously, this year marks also the jubilee of the manufacture of the first gun at Elswick. The entire works have occasionally had in employment as many as 25,000 men, with a weekly pay-bill of £40,000. At the inception in 1847 only 5½ acres were owned by the Company, while now the holding is fully 230 acres.

Parsons marine steam turbines are now being manufactured by the following British shipbuilding and engineering firms, under licence from the Parsons Marine Steam Turbine Company, Limited:—Denny & Company, Dumbarton; Workman, Clark & Company, Limited, Belfast; Wallsend Slipway and Engineering Company, Limited, Wallsend; John Brown & Company, Limited, Clydebank; R. and W. Hawthorn, Leslie & Company, Limited, Newcastle; Fairfield Shipbuilding and Engineering Company, Limited, Glasgow; Richardsons, Westgarth & Company, Limited, Hartlepool; Humphrys, Tennant & Company, London; J. I. Thornycroft & Company, Limited, London; J. Samuel White & Company, Limited, Cowes; Yarrow & Company, Limited, London; Palmers' Shipbuilding and Iron Company, Limited, Jarrow; Harland & Wolff, Limited, Belfast; A. and J. Inglis, Limited, Glasgow; Alex. Stephen & Sons, Limited, Glasgow; Gourlay Brothers & Company (Dundee), Limited, Dundee; Day, Summers & Company, Limited, Southampton; Cammell Laird & Company, Limited, Birkenhead; Thames Iron Works Shipbuilding and Engineering Company, Limited, London; Scott's Shipbuilding and Engineering Company, Limited, Greenock; Sir W. G. Armstrong, Whitworth & Company, Limited, Newcastle; Swan, Hunter & Wigham-Richardson, Limited, Wallsend; Vickers, Sons & Maxim, Limited, Barrow; W. Beardmore & Company, Limited, Glasgow; and the London and Glasgow Engineering and Iron Shipbuilding Company, Limited, Glasgow.

PERSONAL.

The late Mr. S. Nicholls, secretary of the Farnley Iron Company, Limited, has left estate valued at £4,271.

The late Mr. E. Stout, a director of the Wallsend Slipway and Engineering Company, Limited, left estate of the value of £39,326.

Sir Walter Peace has been elected London director of William Simons & Company, Limited, the well-known Renfrew engineering firm.

Mr. T. Gillott, engineer and manager of the works of the Butterley Company, Limited, Derby, has resigned that position owing to ill-health.

Mr. S. Jessop Robinson, managing director of William Jessop & Sons, Limited, Sheffield, has been installed Master of the Cutlers' Company.

The late Mr. J. Wolstenholme, of Messrs. John Wolstenholme & Sons, iron-founders, Radcliffe, Manchester, left estate of the gross value of £9,595.

Mr. F. R. B. Watson has been appointed assistant lecturer and demonstrator in engineering at the Merchant Venturers Technical College, Bristol.

Mr. H. D. McLaren, son of Sir Charles McLaren, M.P., Chairman of Palmers Shipbuilding and Iron Company, Limited, has been elected a director of the Company.

The late Mr. W. Black, founder of Messrs. Black, Hawthorn & Company's engineering works, Gateshead, and the North-Eastern Foundry, South Shields, left estate sworn at £99,345 gross.

In connection with the International Exhibition at Liége, Sir Albert K. Rollit, who is a director of the Blenheim Engineering Company, Limited, has been appointed Grand Officer of the Order of Leopold.

Colonel William Sidebottom has resigned the chairmanship of Cammell Laird & Company, Limited, and Mr. J. M. Laird, who has acted as deputy chairman, has been elected to fill the vacancy. Colonel Sidebottom has consented to take the position of deputy chairman.

OBITUARY.

PROFESSOR DR. FRANZ REULEAUX, the well-known German engineer.

MR. T. M. WELSH, of the firm of R. & J. Inglis, Limited, engineers and shipbuilders, Glasgow.

MR. CHARLES BROWN, of Bâle, an engineer who took a prominent part in the development of the machinery industry in Switerland.

SIR WILLIAM SHELFORD, for many years member of the Council of the Institution of Civil Engineers, and well known in Westminster as a consulting engineer.

MR. C. WIDDOWSON, of Abergavenny, who for 40 years held an important position under the Tredegar Iron and Coal Company, and was chief cashier for 37 years.

MR. A. MORCOM, Chairman of the firm of Belliss & Morcom, Limited, engineers, of Birmingham, at his residence, Trelawne, Edgbaston, after a short illness. Mr. Morcom was only 57 years of age.

MR. J. CAMPBELL, head of the Hunslet Engine Company, at his residence, Roseneath, Newton Park, Leeds, in his 68th year. He served his apprenticeship at the old Railway Foundry, under his father, and acquired a thoroughly practical knowledge of engineering.

MR. JOSEPH GAMBLE, at his residence, Southbourne, Clarkehouse Road, Sheffield. The deceased gentleman, who was over 80 years of age, joined his brother and Mr. J. Moss, and started the business of Moss & Gamble Brothers. Subsequently the firm took the Globe Melting Furnaces, the Walkley Bank Tilt, and the Wadsley Bridge Steel Works. He was also a director of John Round & Son, Limited, Davy Brothers, Limited, and Ibbotson Brothers & Company, Limited.

SIR EDWARD HAMER CARBUTT, at his residence at Cranleigh, near Guildford, in his 67th year. The deceased gentleman was the representative of the Institution of Mechanical Engineers in the National Physical Laboratory, and of the Iron and Steel Institute on Sir W. H. White's Committee to formulate a scheme of education for engineers. He was a past President of the Institution of Mechanical Engineers, a member of the Institution of Civil Engineers, and a Vice-President and one of the original members of the Iron and Steel Institute.

ELDERS FOUNDRY COKE

As supplied to the British . . Admiralty Dockyards.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.

We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blow-holes and other defects, than we formerly did.

From MOUNTFORT PHILLIPS & Co., Llantrissant.

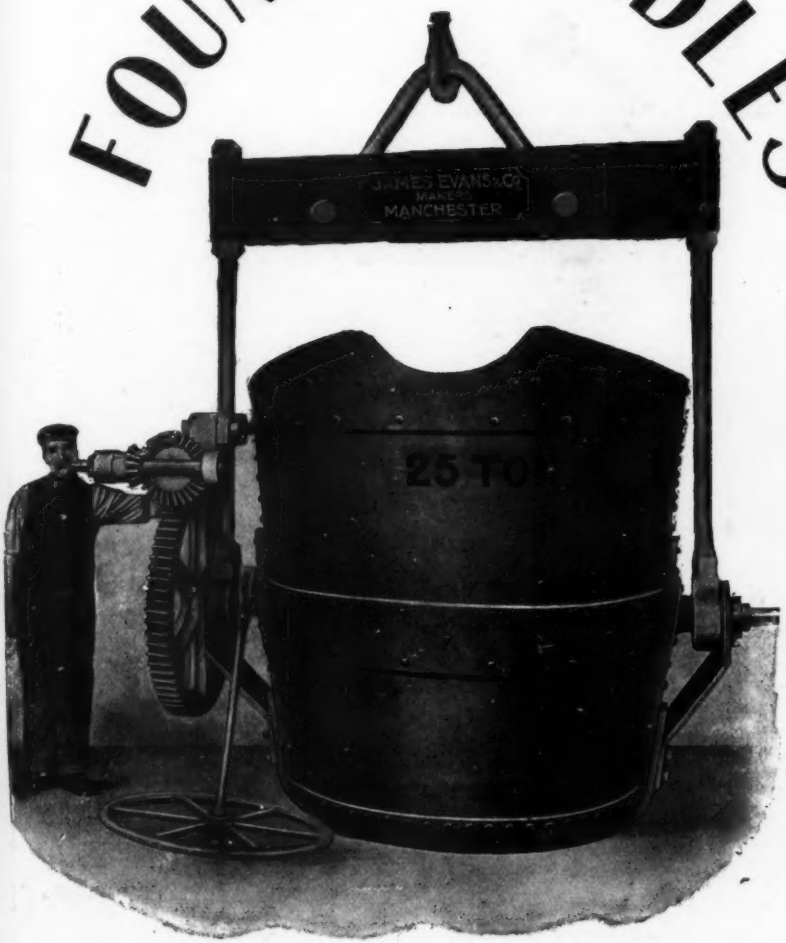
Llantrissant, October 25th, 1904.

In reference to the Foundry Coke you have been supplying us with for the last six months, we have very great pleasure in letting you know that it has given every satisfaction, and that our Works Manager and Workmen give it the highest praise.

Elders Navigation Collieries, LTD. Cardiff.

Contractors to H.M. Government.

FOUNDRY LADLES



JAMES EVANS & Co., FOUNDRY ENGINEERS,

Telegrams: "LADLES, MANCHESTER."

BRITANNIA WORKS, MANCHESTER.

QUERIES.

"P. B. T."—In answer to "P. B. T.'s" query in October issue of FOUNDRY TRADE JOURNAL, if he cares to write to J. W. Marwood, 31, Sun Street, Derby, he will no doubt give him some valuable information on this subject.

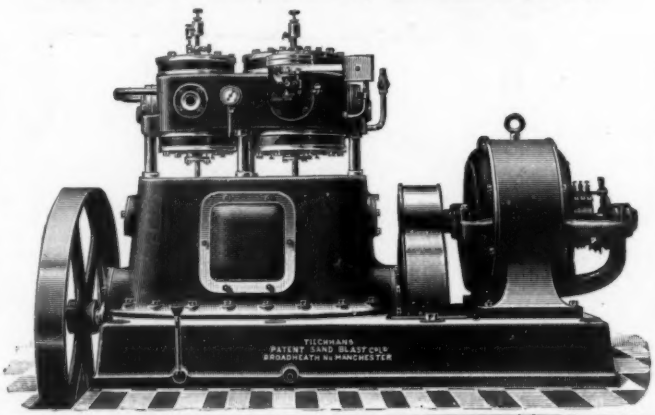
* * *

CASTING BRONZE ROUND AN IRON CENTRE.—"D. B." writes:—"We have tried casting a number of gun-metal and also phosphor bronze rings around a cast-iron centre, which we heat to a dark red before pouring around our bronze or gun-metal. These rings vary from 12 in. diameter to 5 ft. diameter, and from 1 in. to 3 in. in thickness, and 2 in. to 6 in. in width. We have deep grooves to cut into these rings, but have been sorely troubled with their showing blow-holes when we machine down into them. Is there any way of overcoming this?"

AIR COMPRESSORS

DRIVEN BY STEAM, BELT, OR ELECTRICITY.

HORIZONTAL & VERTICAL.
Single Stage & Compound Types.



High efficiency, Silent working and 12 months guarantee.

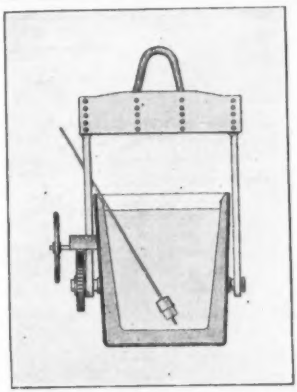
SAND BLAST APPARATUS for cleaning large & small Castings, either steel, iron or gun metal.

Tilghman's Patent Sand Blast Company, Ltd.,
BROADHEATH, near MANCHESTER.

Ganister, Cupola Blocks, Fire Bricks,
Fire Clay.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
Steel Moulders' Composition, Silica Cement.

J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

PREVENTION OF BLOWHOLES IN CAST IRON.



A tin of our special compound fixed on a rod is held at bottom of ladle as shown; a strong re-action being thereby set up frees the iron from gases and impurities, which rise to the top.

RESULT: A denser casting of finer grain with increased strength.

For Particulars apply to—

THERMIT LIMITED,

27, MARTIN'S LANE, CANNON STREET,

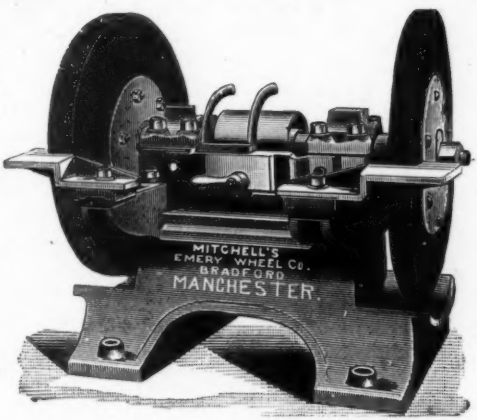
Telephone—3749 Central.
Telegrams—"Fulmen," London.

LONDON, E.C.

MACHINES. For all Purposes. **WHEELS.**

Complete with Emery or Corundum Wheels from **£2** upwards.

Special Machines Designed.



Emery or Corundum from 1 in. x $\frac{1}{8}$ in. to 50 in. x 12 in.

Enquiries solicited.

MITCHELL'S EMERY WHEEL Co.,

Mill Street, Bradford, MANCHESTER.

Also at LONDON, GLASGOW, and BELFAST. LISTS FREE.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

Metals.	1904-5.	1903-4.
Iron—Scotch pig warrant ... ton	—	—
—Middlesbro' warrants ... ... ton	52/3	45/10
—W.C. M/nos Bessemer ... ... ton	72/0	53/6
—Stock, Scotch, Oct. 5 ... ...tons	16,377	9,520
Copper—Chili bars, GMB ... ... ton	£71 12/6	£62 12/6
—Stock, Europe & afloat... ... tons	15,772	13 490
Tin—English ingots ton	£152 0/0	£134 0/0
—Straits ... ton	£149 10/0	£132 10/0
—Stock, Ldn. Hind and aft ... tons	12,109	13,390
Lead—English pig ton	£15 7/6	£12 15/0
Spelter—Ord. Silesian ... ... ton	£28 7/6	£23 16/3
Quicksilver-(75lb.) bottle	£7 5/0	£7 15/0
Antimony—Regulus ... ... ton	£51 0/0	£27 15/0

Castings.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 12 6	to	7 2 6
Pipes, 1½ to 2½ in.	5 0 0	to	5 2 6
,, 3 to 4 in....	4 12 6	to	5 0 0
,, 5 to 8 in.	4 10 0	to	4 12 6
,, 10 to 16 in....	4 10 0	to	4 12 6
,, 18 to 24 in.... ...	4 10 0	to	4 12 6
Chairs	3 12 6	to	3 15 0
Floor plates (open sand)	3 2 6	to	3 5 0

Scrap.

The quotation for scrap subject to market fluctuations is as follows: —Engineers' heavy scrap, 55s. to 60s.; ditto light scrap, 22s. 6d. to 25s.; clean scrap brass, 41s. 6d.; clean scrap copper, 65s.; lead (usual draft), 13s.; tea lead, 11s. 9d.; zinc, 21s. 6d.; hollow pewter, 105s.; black pewter, 70s. per cwt.

SILICA FIRE BRICK Co.,

OUGHTIBRIDGE.

GROUND GANISTER,

Wet or Dry.

Silco Cupola Bricks, 90 % Silica.

Established 1863.

Jas. Durrans & Sons,

PHŒNIX WORKS, PENISTONE,

Nr. Sheffield.

Manufacturers of all

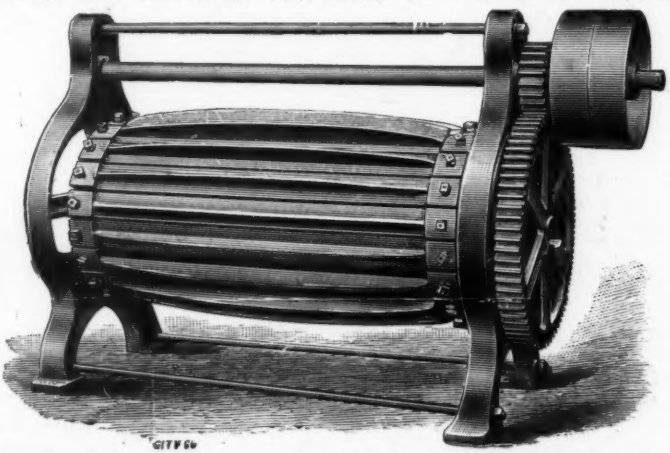
FOUNDRY EQUIPMENTS

Composition Black Lead,

Plumbago, Core Gum, White Dust, and Coal Dust.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, &c.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

PATENT HYDRAULIC CORE-MAKING MACHINE,

PATTERN "M B."

THIS MACHINE IS CAPABLE OF MAKING CORES OF ALMOST ANY DESCRIPTION AND HAS AN IMMENSE CAPACITY. ALSO CONSTRUCTED FOR HAND OR COMPRESSED AIR.

Send us Sketches of your Cores and we will submit proposals.

MOULDING MACHINES, SAND-MIXERS, &c.

THE LONDON EMERY WORKS CO. PARK, TOTTENHAM, LONDON, N.

(DEPARTMENT "C.")

The NEW

Portable Mould Drier

The Latest Foundry Time Saver.

J. W. & C. J. PHILLIPS,

Engineers

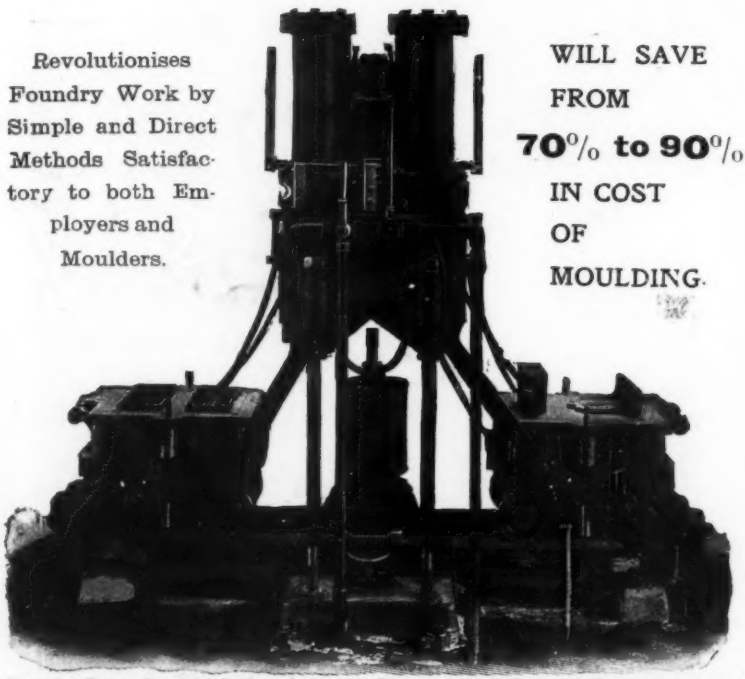
23, COLLEGE HILL, LONDON, Eng.

Telegrams: "COLLOQUIAL, LONDON." Telephone: 10122 CENTRAL.

The McClelland Patent

SAND MOULDING MACHINE

Revolutionises Foundry Work by Simple and Direct Methods Satisfactory to both Employers and Moulders.



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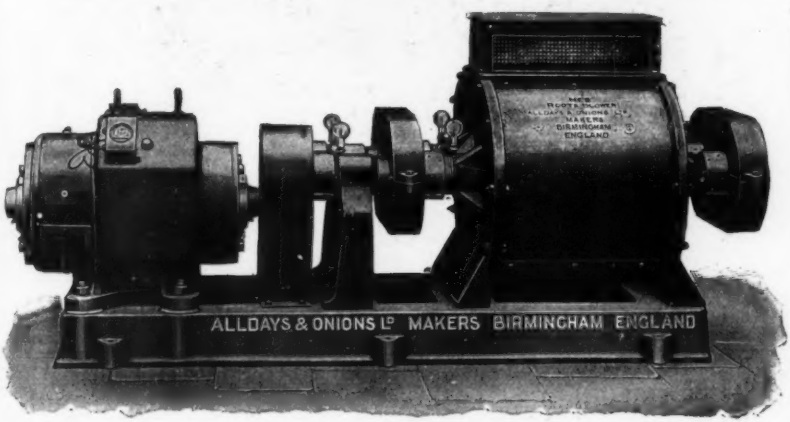

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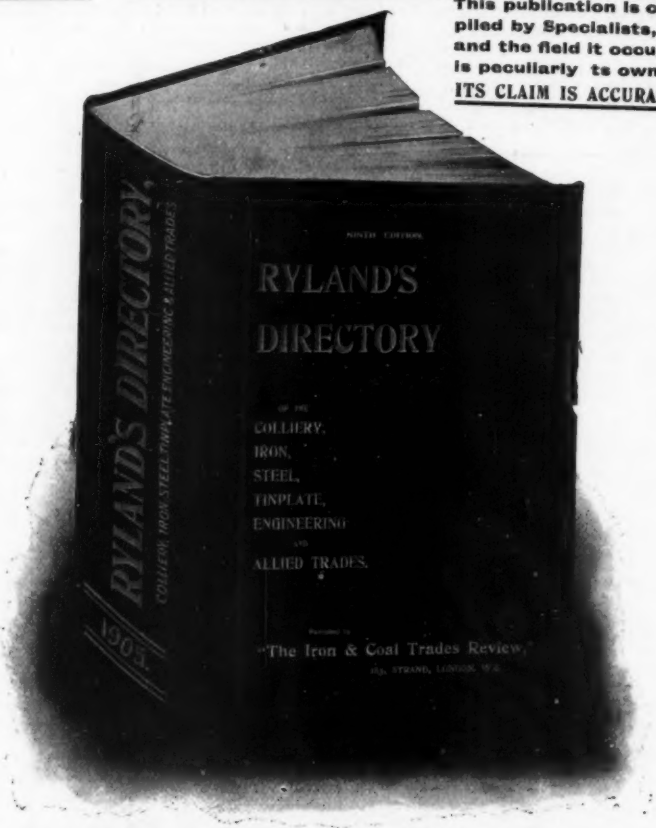

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